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DIFFUSION NOMOGRAMS AND TABLES FOR ROCKET PROPELLANTS AND COMBUSTION BY-PRODUCTS

By
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and
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ROCKET PROPELLANTS AND COMBUSTION BY-PRODUCTS

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ABSTRACT

An empirical diffusion equation is numerically evaluated to provide average downwind travel distances and average concentrations in terms of measured temperature differentials near the earth's surface. The resultant nomograms and tables for twelve rocket propellants and a combustion by-product may be used to estimate the hazard corridors associated with toxic vapors from these chemical compounds.

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INTRODUCTION

The purpose of this report is to present in tabular and graphical form information pertaining to travel distances from a continuous point source of toxic vapors associated with highly reactive rocket propellants or the by-products of combustion. The information revealed by this study forms a basis for the prediction of hazard corridors and determining average concentrations of dangerous vapors that result from the release of toxic compounds into the atmosphere.

The travel distance nomograms and tables for various compounds were developed using an empirical diffusion model originally developed by Miller and Miller (1963). The empirical model is generally valid over a variety of quasi-homogeneous terrains and yields results which are considered reliable within a factor of 2 to 4.

THE PREDICTION EQUATION

The prediction equation was determined from regression analysis of experimental data pertaining to the diffusion of matter into the atmosphere from a continuous point source. Miller and Miller (1963) found that an adequate expression took the form

$$\frac{C_p}{Q} = 0.000175 x^{-1.95} (\Delta T + 10)^{4.95} \quad (1)$$

where C_p is the peak concentration in gm m^{-3} at a height of about 1.5 m above the surface at a downwind travel distance x , Q is the source strength in gm sec^{-1} and ΔT is a temperature differential in deg F over an arbitrary layer between 1.83 and 16.46 meters above the surface. The constant 10 is added to ΔT to avoid raising a negative value to a power. Solving eq (1) in terms of the downwind travel distance of a contaminant yields

$$x = A \left(\frac{C_p}{Q} \right)^b (\Delta T + 10)^c \quad (2)$$

where b and c are universal constants and A is a function of the gram molecular weight of the contaminant.

For practical applications of eq (2), it must be expressed in units which may be easily determined. This is accomplished by converting gm m^{-3} of the respective gaseous contaminants to parts per million by volume under standard conditions and converting gm sec^{-1} to lb. min^{-1} . The conversion is fairly simple, involving the use of a factor for the appropriate contaminant. Usually, C_p/Q is best expressed as ppm/lb min^{-1} . Under standard conditions $1 \text{ ppm/lb min}^{-1}$ equals the gram molecular weight of the gaseous contaminant times $5.89 \times 10^{-6} \text{ sec m}^{-3}$. To obtain parts per million per pounds per minute, C_p/Q is multiplied by 1.70×10^5 and divided by the gram molecular weight. Then A in eq (2) is calculated from $(1.70 \times 10^5 \div \text{gm. mol. wt.} \times .000175)^{.513} \times 3.28 \frac{\text{feet}}{\text{meter}}$. The downwind travel distance x is given in terms of feet from the source.

PROPELLANTS USED IN STUDY

The rocket propellants used in this study are listed in Table 1. Also included is a toxic by-product of combustion, namely hydrogen fluoride which results from the use of liquid hydrogen as a fuel and fluoride as an oxidizer. Table 1 includes threshold limit values, also known as maximum allowable concentrations (MAC) which constitute average daily exposure values. Concentrations less than the MAC per normal work day should not have an adverse effect on personnel. Threshold limit values for each compound are given in terms of parts per million (ppm), that is, the volume of the contaminant per million volumes of air and in milligrams per cubic meter of air. The standards for MAC values are those recommended by the American Conference of Government Industrial Hygienists. Included in Table 1 are the values of A in eq (2) for each contaminant.

DISCUSSION

Eq (2) was evaluated numerically using digital computer techniques for C_p/Q over the range $0.001 < C_p/Q < 3.00$ and

TABLE 1. Toxic Chemical Compounds

COMPOUND	CHEMICAL STRUCTURE	GRAM MOLECULAR WEIGHT	THRESHOLD ppm	THRESHOLD mgm ⁻³	FACTOR A
Aniline	$C_6H_5NH_2$	93.130	5.0	19.0	1.8239
Chlorine Trifluoride	ClF_3	92.450	0.1	0.4	1.8307
Ethylene Oxide	C_2H_4O	44.050	50.0	90.0	2.6779
Fluorine	F_2	37.996	0.1	0.2	2.8889
Hydrazine	N_2H_4	32.050	1.0	1.3	3.1524
Hydrogen Fluoride	HF	20.010	3.0	2.0	4.0204
Hydrogen Peroxide	H_2O_2	34.010	1.0	1.4	3.0579
*Monomethyl Hydrazine	CH_3NHNH_2	46.070	0.5	0.9	2.6170
Nitric Acids, Fuming	HNO_3	63.020	5.0	9.0	2.6187
**Nitrogen Tetroxide	N_2O_4	46.010	5.0	9.0	2.6187
Pentaborane	B_5H_9	63.130	0.005	0.01	2.2265
Perchloryl Fluoride	ClO_3F	102.450	3.0	13.5	1.7368
Propyl Nitrate, Normal	$C_3H_7NO_3$	105.090	25.0	110.0	1.7143
Unsymmetrical Dimethylhydrazine	$(CH_3)_2NNH_2$	60.100	0.5	1.0	2.2834

* Suggested threshold value of 0.5 ppm

** Threshold values in terms of NO_2 . MAC for N_2O_4 is 2.5 ppm.

for values of ΔT in the range $-3.0^{\circ}\text{F} < \Delta T < 9.0^{\circ}\text{F}$. The results in terms of travel distances for each of the 14 contaminants are given in Tables 2 through 14 and Figures 1 to 13. No tables or nomograms were prepared for the fuming nitric acids, since the values are identical to those for N_2O_4 which should be used for these oxidizers. The tables are condensed versions of those obtained from the computer runs.

It should be noted that the mean wind speed and the standard deviation of wind direction do not appear in either eq (1) or (2), even though these parameters are factors in determining the longitudinal and lateral dispersion of a contaminant. Miller and Miller (1963) showed that while C_p/Q is a function of wind speed, the inclusion of wind speed in the equation does not contribute significantly to the predictability of C_p/Q after the inclusion of the temperature differential in the equation. Used separately, the mean wind speed is quite useful in determining travel time.

Since eqs (1) and (2) were developed primarily as simple practical expressions for use in the field with a minimum of instrumentation, the standard deviation of wind direction was omitted since there is no recognized way to determine sigmas from, say, an analogue wind direction recorder trace. The lateral dispersion of a contaminant and hence the width of a hazard corridor are determined separately. It was found by Miller and Miller (1963) and Haugen and Taylor (1963) that within a factor of 2 or 4, the lateral spread of a contaminant downstream of a continuous point source may be approximated by eight standard deviations of wind direction. It was also found that the lateral spread expressed as a range could be approximated from $W = 1.8R$ where W is the width of the hazard corridor in degrees and R is an arbitrary range of wind directions determined from a recorder trace. Values of R may be found by eliminating three peaks on each side of the mean wind direction and then finding the spread less these six peaks. This is a valid approach if the recorder speed is from 3 to 6 inches per hour and the sampling time is on the order of 30 minutes to an hour. This empirical scheme is limited to wind direction recorders with 5 ma movements and a 3 to 4 second full-scale response time.

CONCLUSIONS

The average downwind travel distances of various toxic gases as predicted by the simplified model for atmospheric diffusion have been presented. The values derived for these contaminants are considered to be valid within a factor of 2 to 4 for releases of toxic vapors into the atmosphere. The tables and nomograms may be used to provide diffusion predictions for the compounds included in this report for the indicated atmospheric conditions.

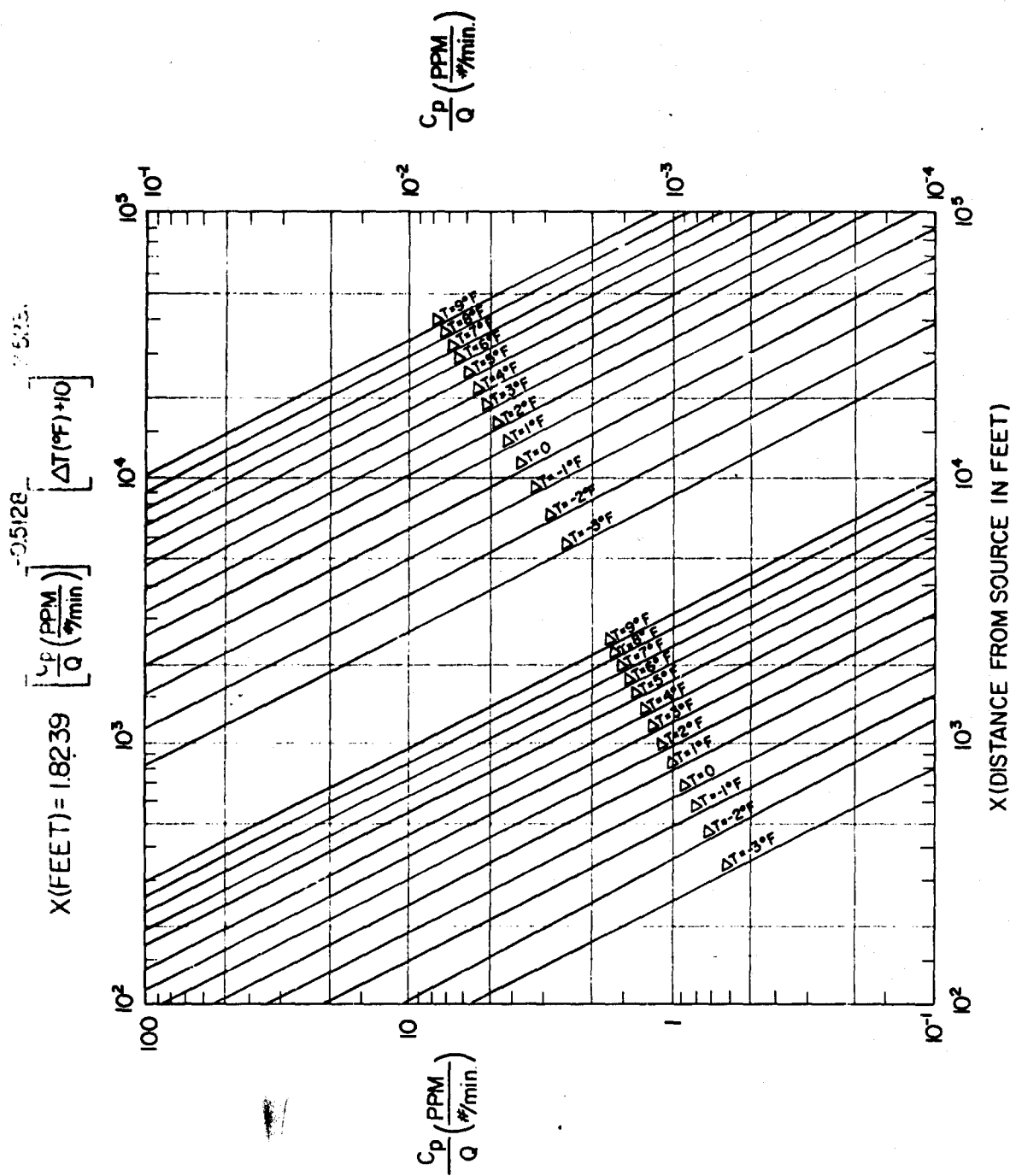


FIGURE 1 . DIFFUSION NOMOGRAM FOR ANILINE ($\text{C}_6\text{H}_5\text{NH}_2$).
 THRESHOLD VALUE (MAC) IS 5PPM OR 19MG/M³.

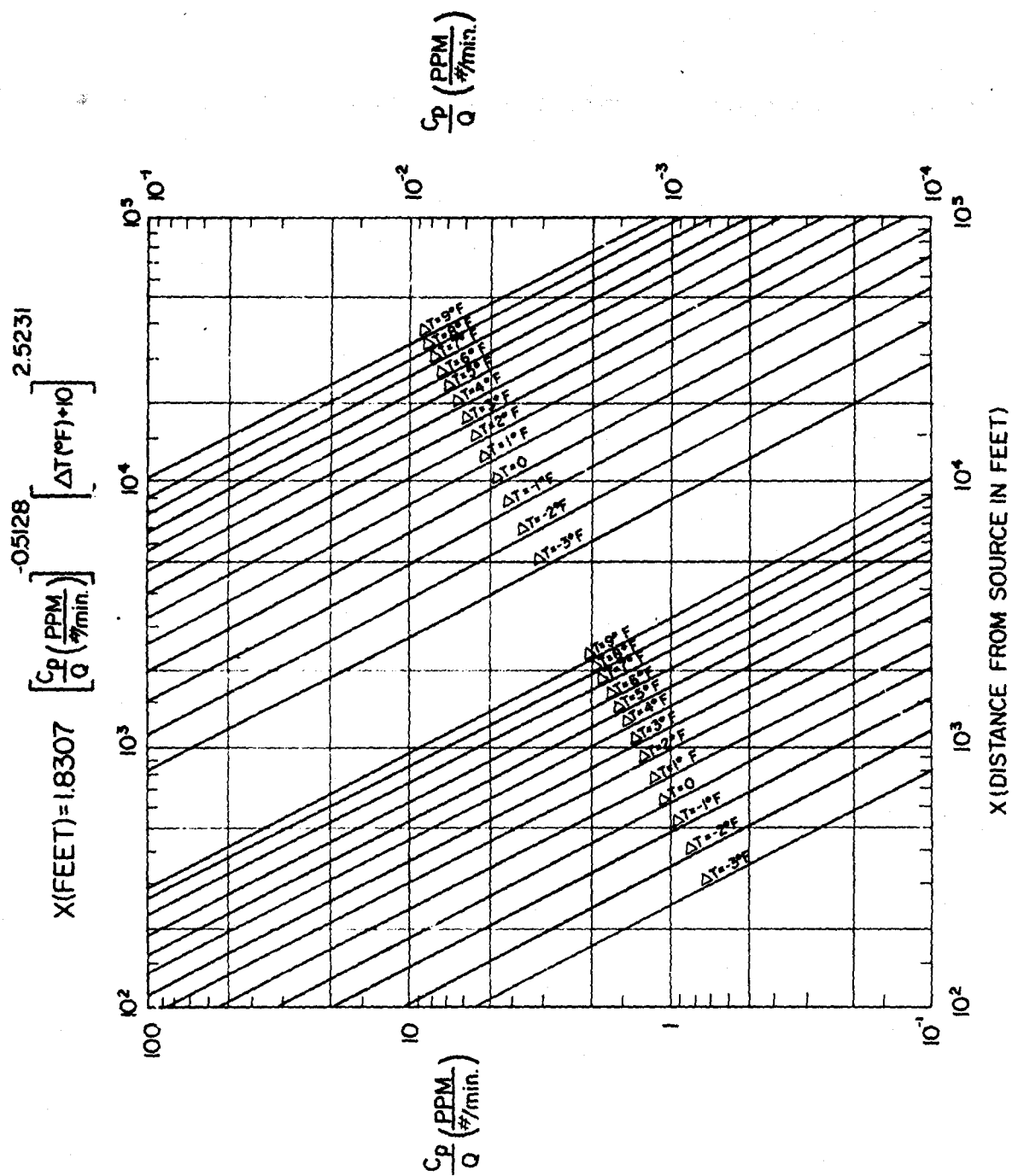


FIGURE 2 DIFFUSION NOMOGRAM FOR CHLORINE TRIFLUORIDE
 (ClF₃) THRESHOLD VALUE (MDS) 5 CLPPM OR
 0.4 MG/M³

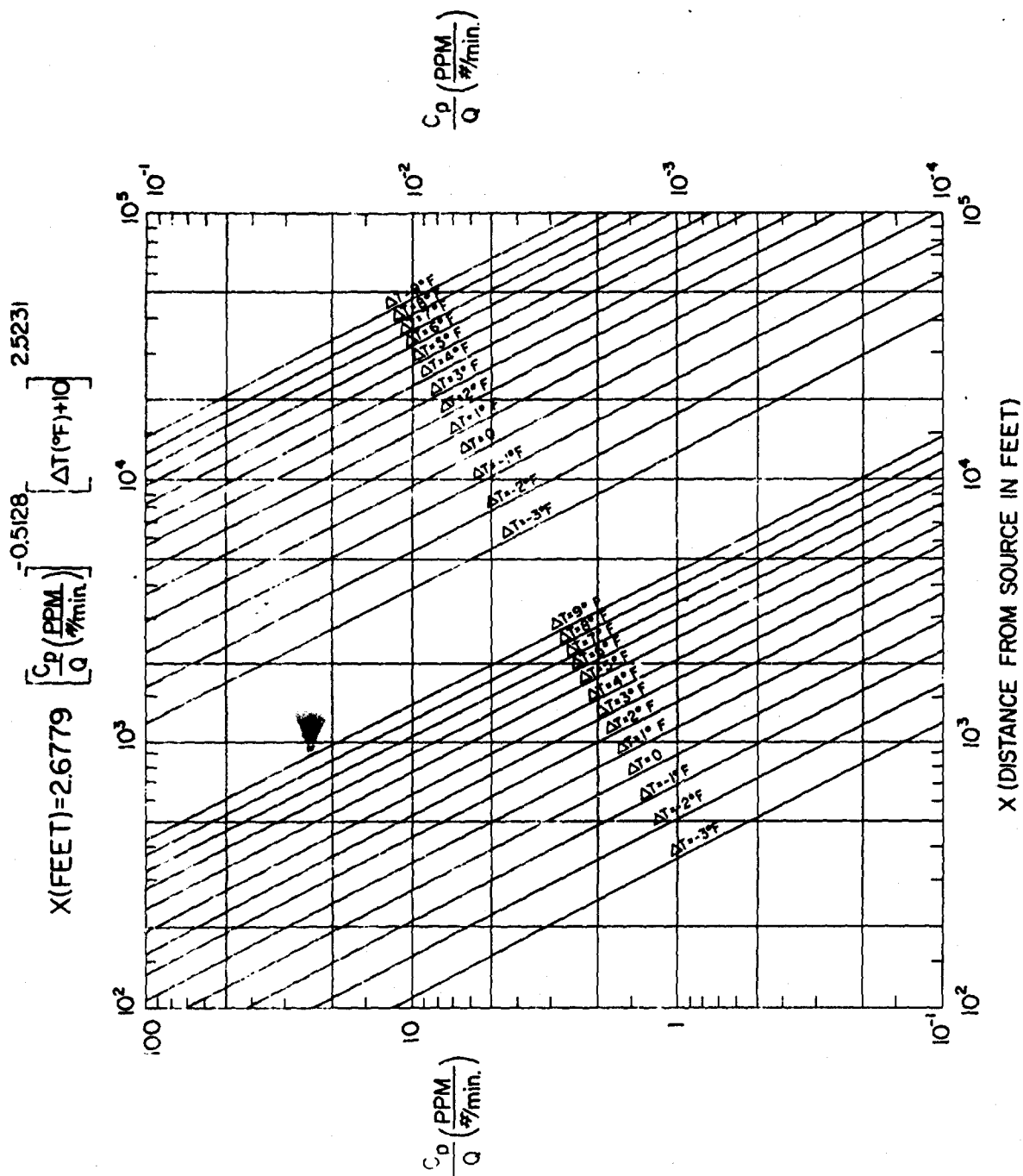


FIGURE 3. DIFFUSION NOMOGRAM FOR ETHYLENE
OXIDE [C₂H₄O]. THRESHOLD VALUE [MAC]
IS 50 PPM OR 100 MG/M³

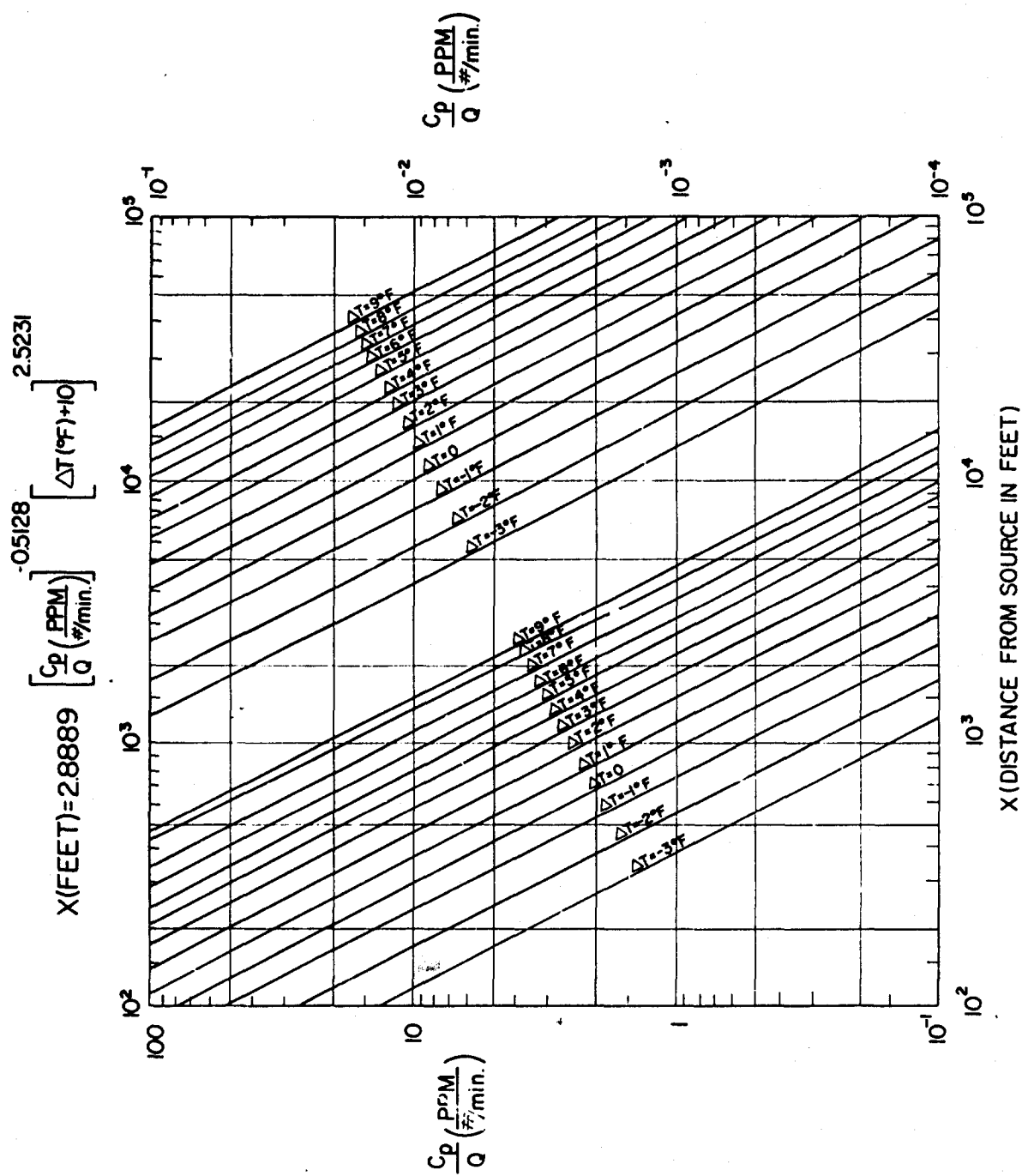


FIGURE 4 . DIFFUSION NOMOGRAM FOR FLUORINE (F_2).
 THRESHOLD VALUE (MAC) IS 01 PPM OR 02 MG/M³

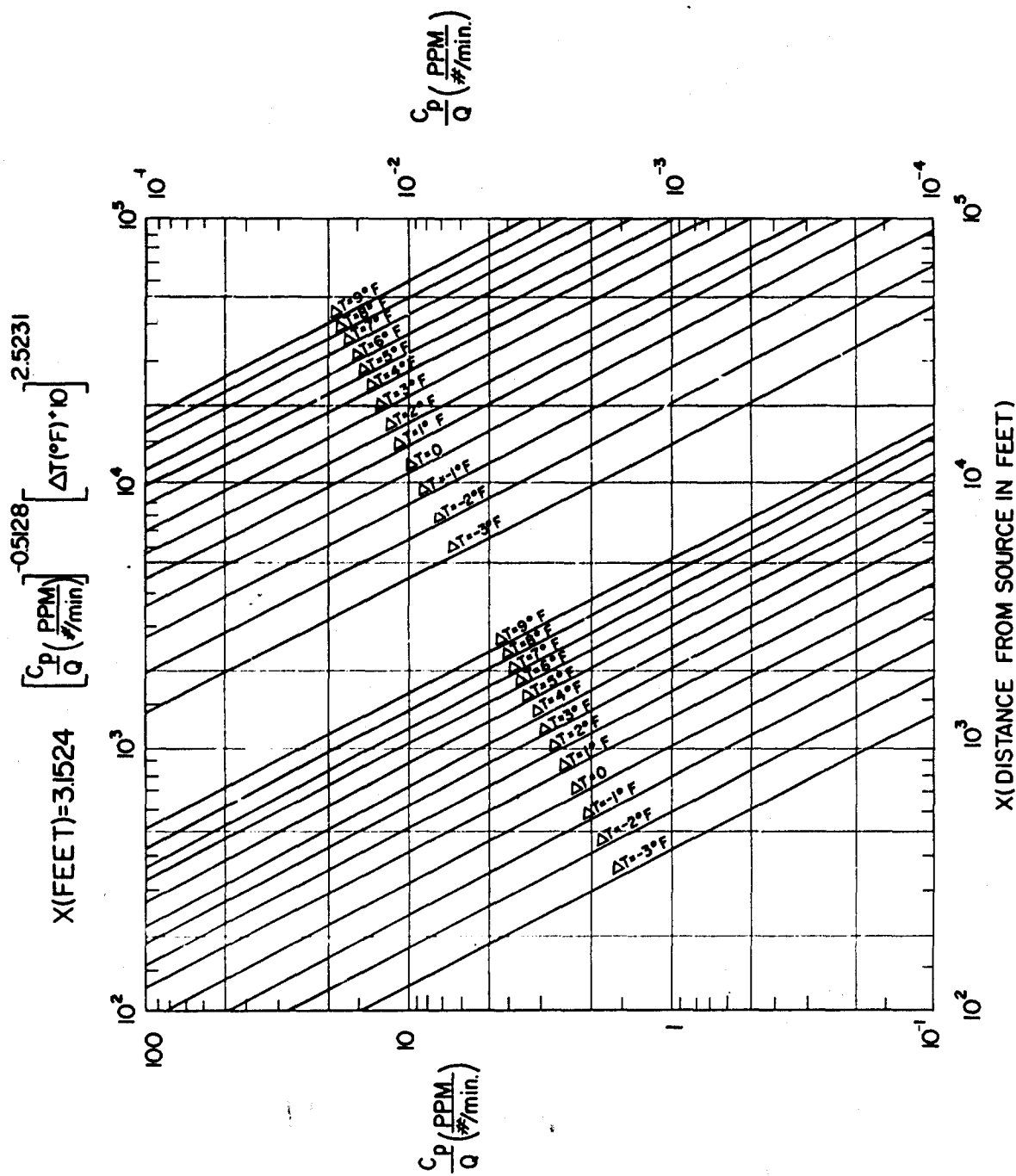


FIGURE 5 . DIFFUSION NOMOGRAM FOR HYDRAZINE(N_2H_4).
 THRESHOLD VALUE (MAC) IS 1 PPM OR 1.3 MG/M³.

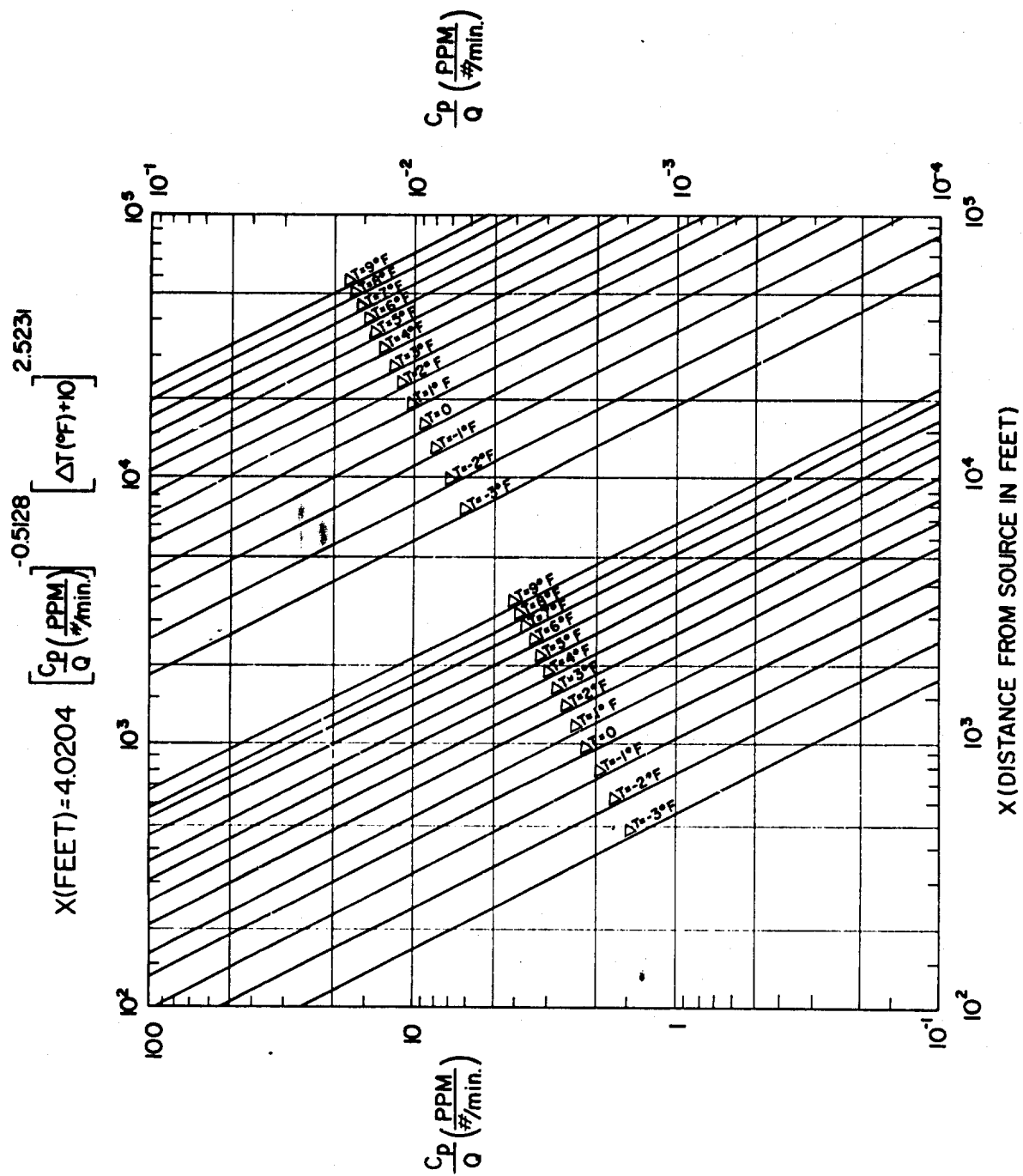


FIGURE 6 . . DIFFUSION NOMOGRAM FOR HYDROGEN FLUORIDE (HF). THRESHOLD VALUE (MAC) IS 3 PPM OR 2 MG/M³.

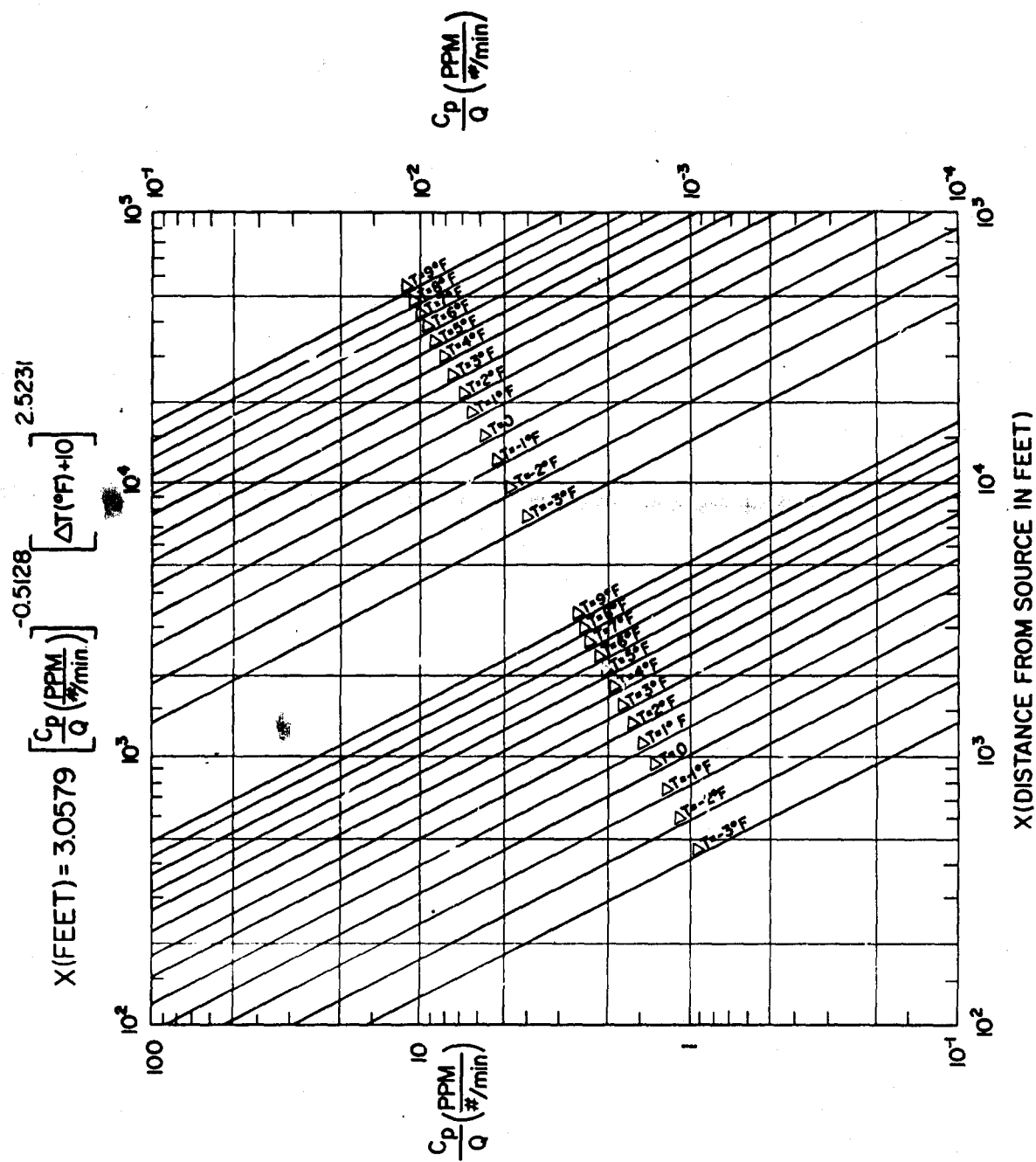


FIGURE 7 . DIFFUSION NOMOGRAM FOR HYDROGEN PEROXIDE (H_2O_2). THRESHOLD VALUE (MAC) IS 1 PPM OR 1.4 MG/M³.

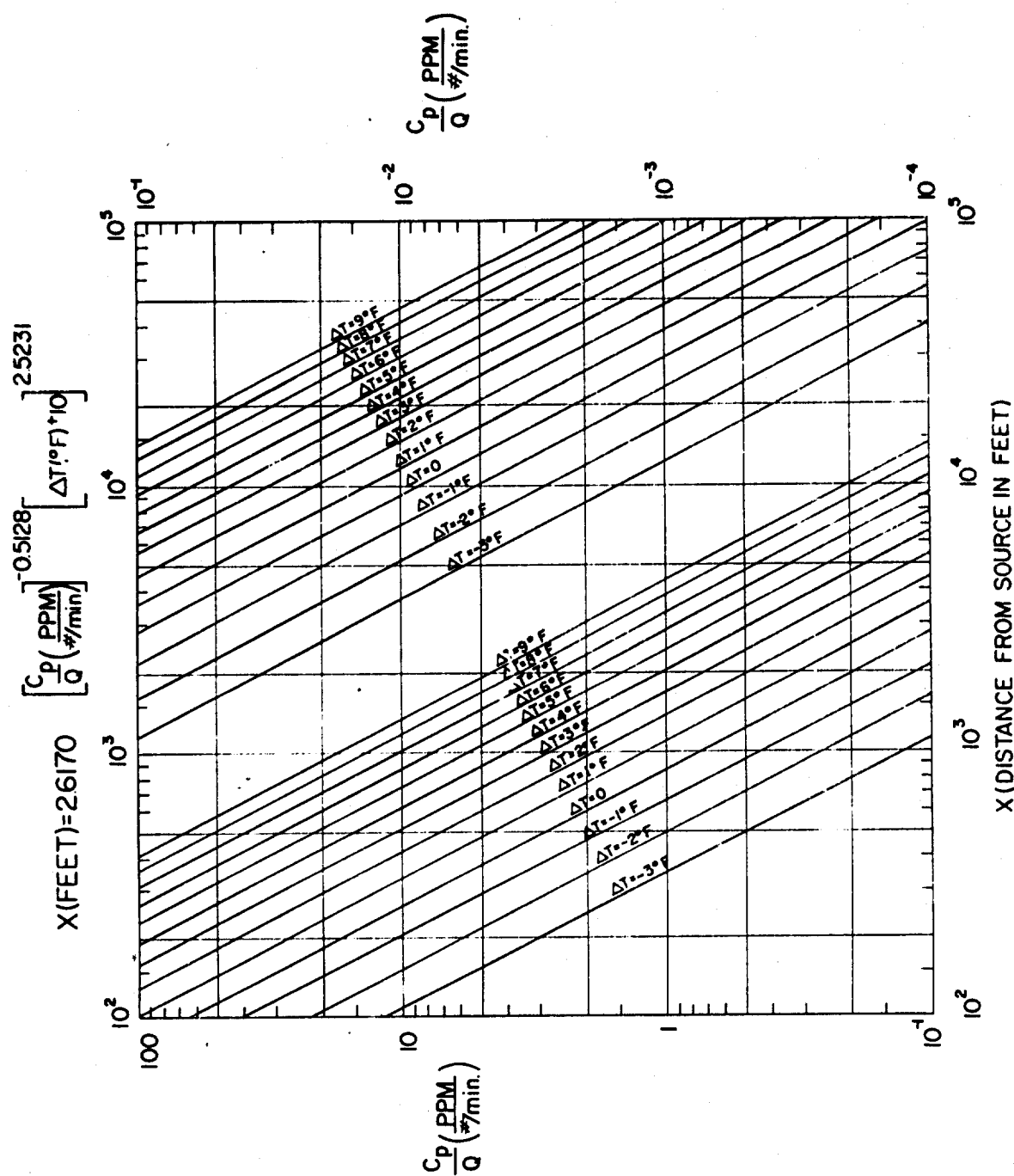


FIGURE 8 . DIFFUSION NOMOGRAM FOR MONOMETHYLHYDRAZINE
 (CH_3NHNH_2). NO THRESHOLD VALUE (MAC) CURRENTLY
 AVAILABLE. SUGGESTED VALUE IS 0.5 PPM.

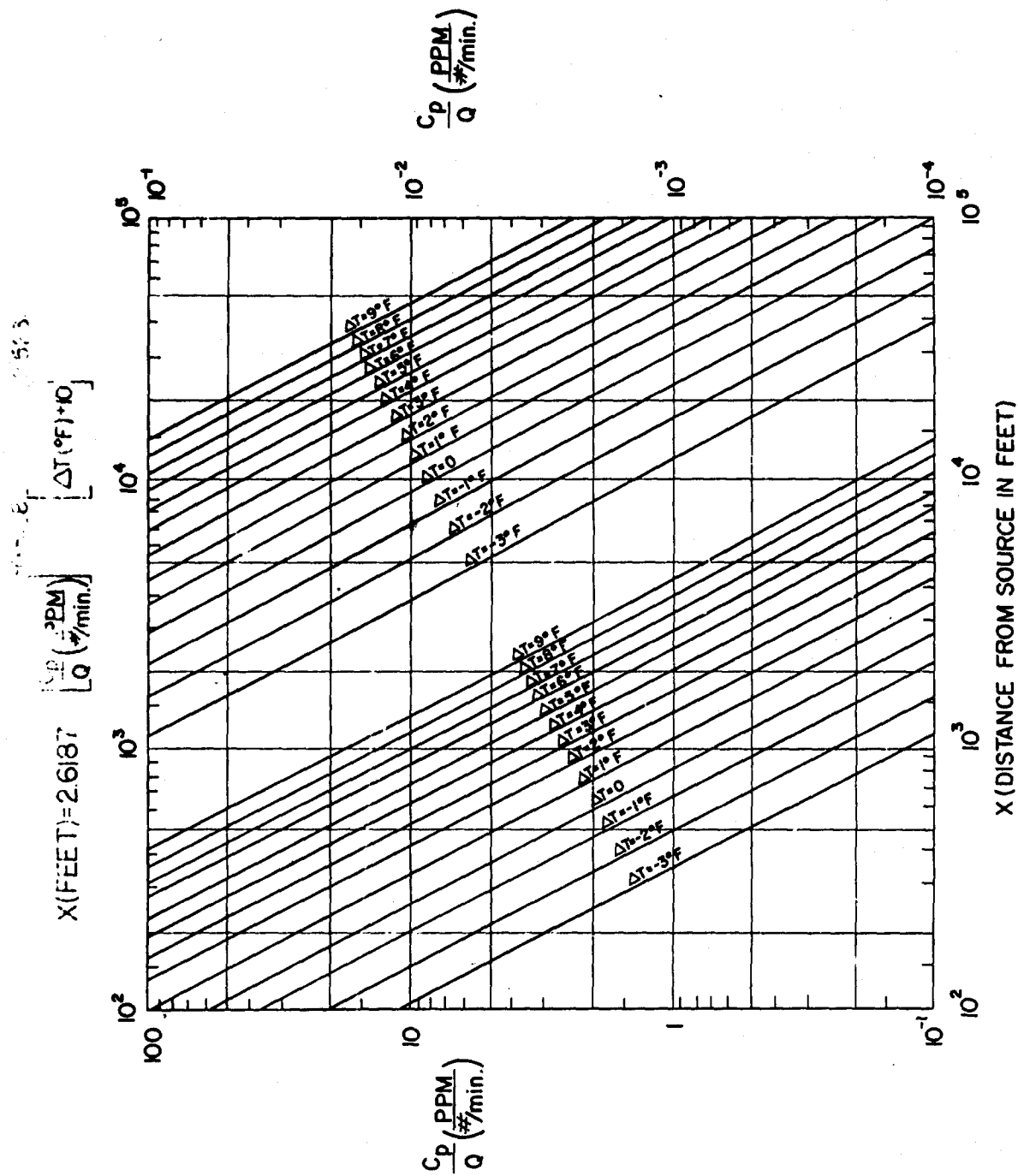


FIGURE 9 . DIFFUSION NOMOGRAM FOR NITROGEN TETROXIDE
 [N_2O_4]. THRESHOLD VALUE (MAC) IS
 5 PPM OR 9MG/M³.

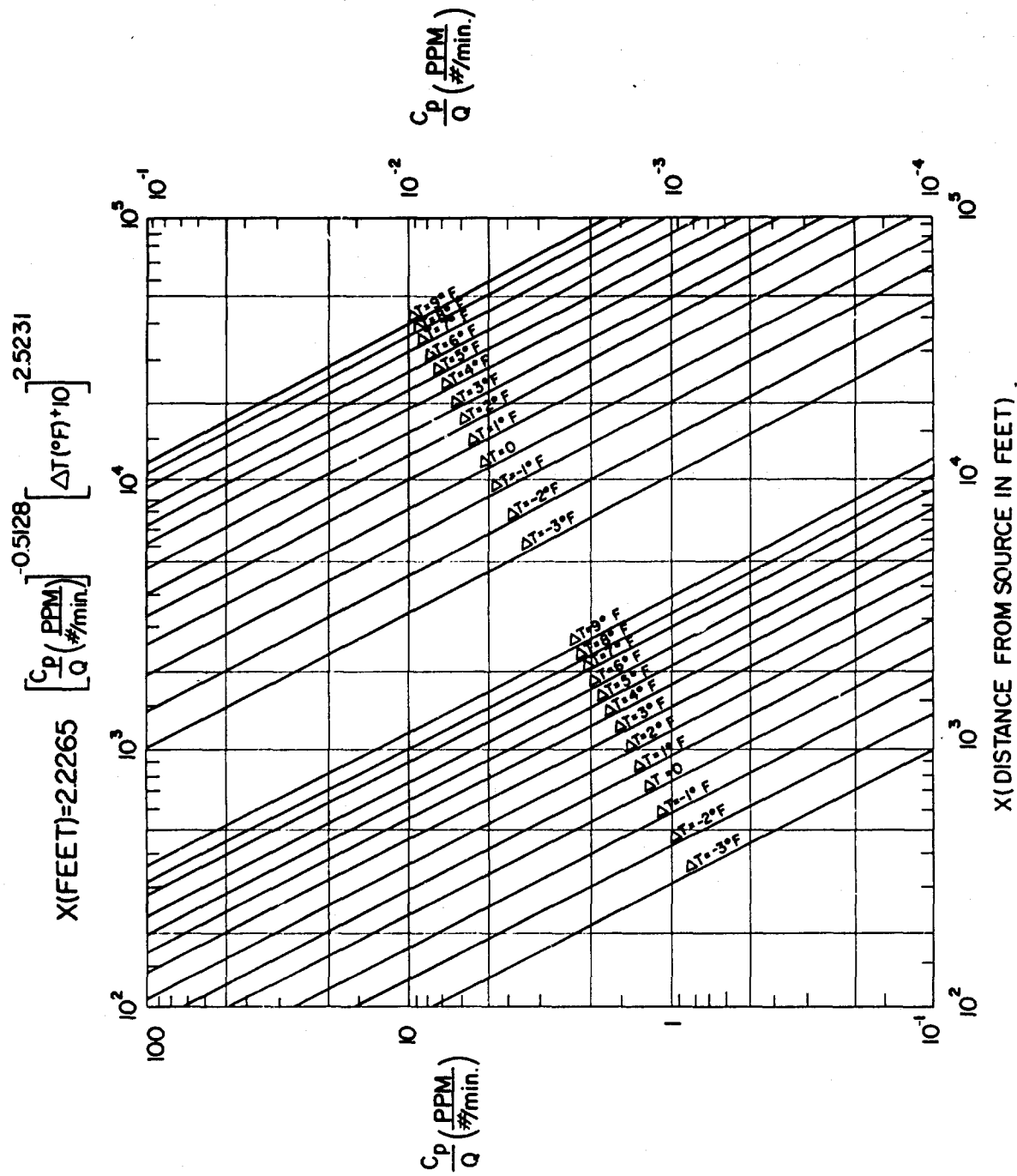


FIGURE 10. DIFFUSION NOMOGRAM FOR PENTABORANE (B_5H_9).
 THRESHOLD VALUE (MAC) IS 0005 PPM OR
 0.01 MG/M³

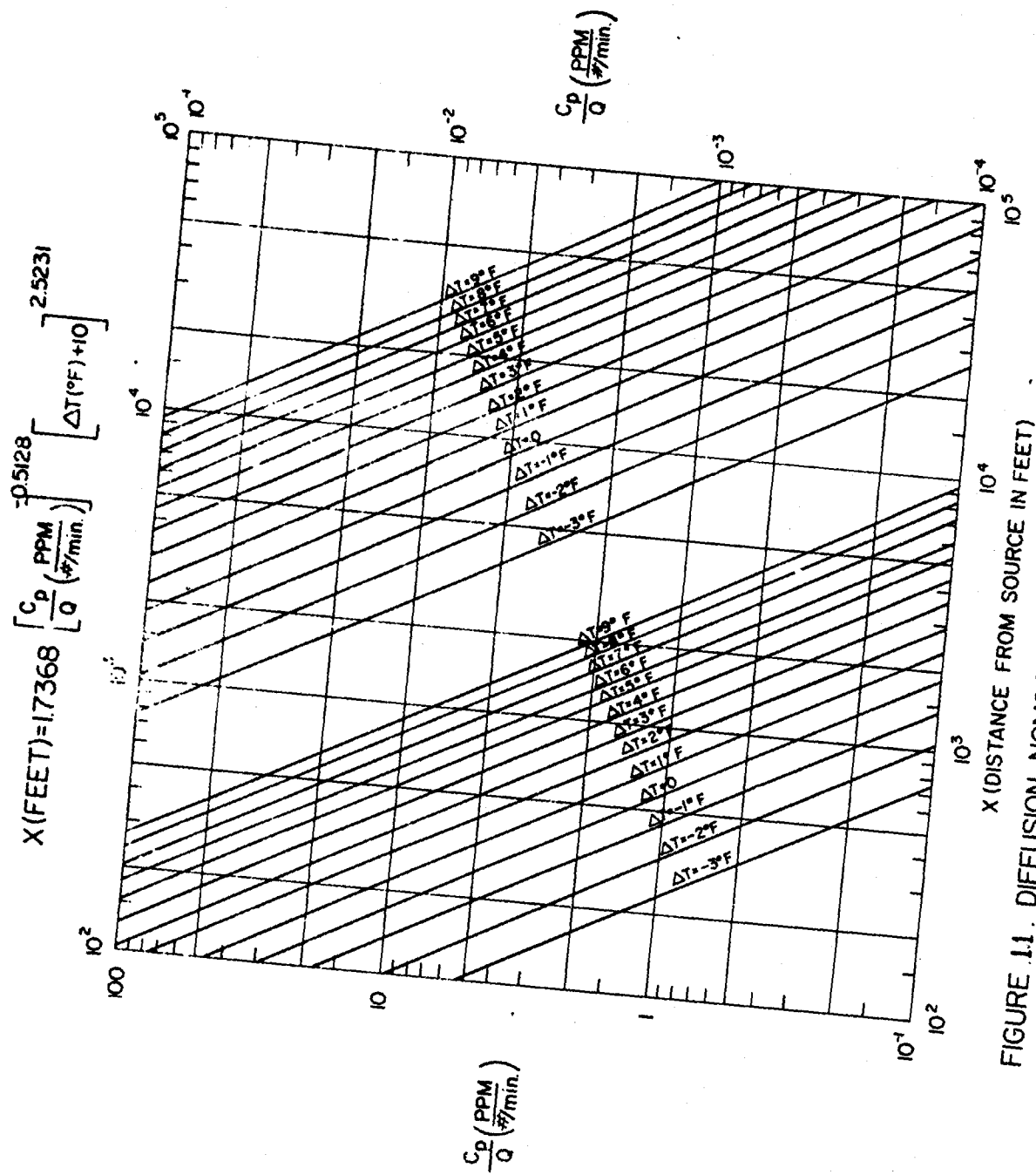


FIGURE 1.1. DIFFUSION NOMOGRAM FOR PERCHLORYL FLUORIDE
 (ClO_3F). THRESHOLD VALUE (MAC) IS 3PPM OR 13.5 MG/M³

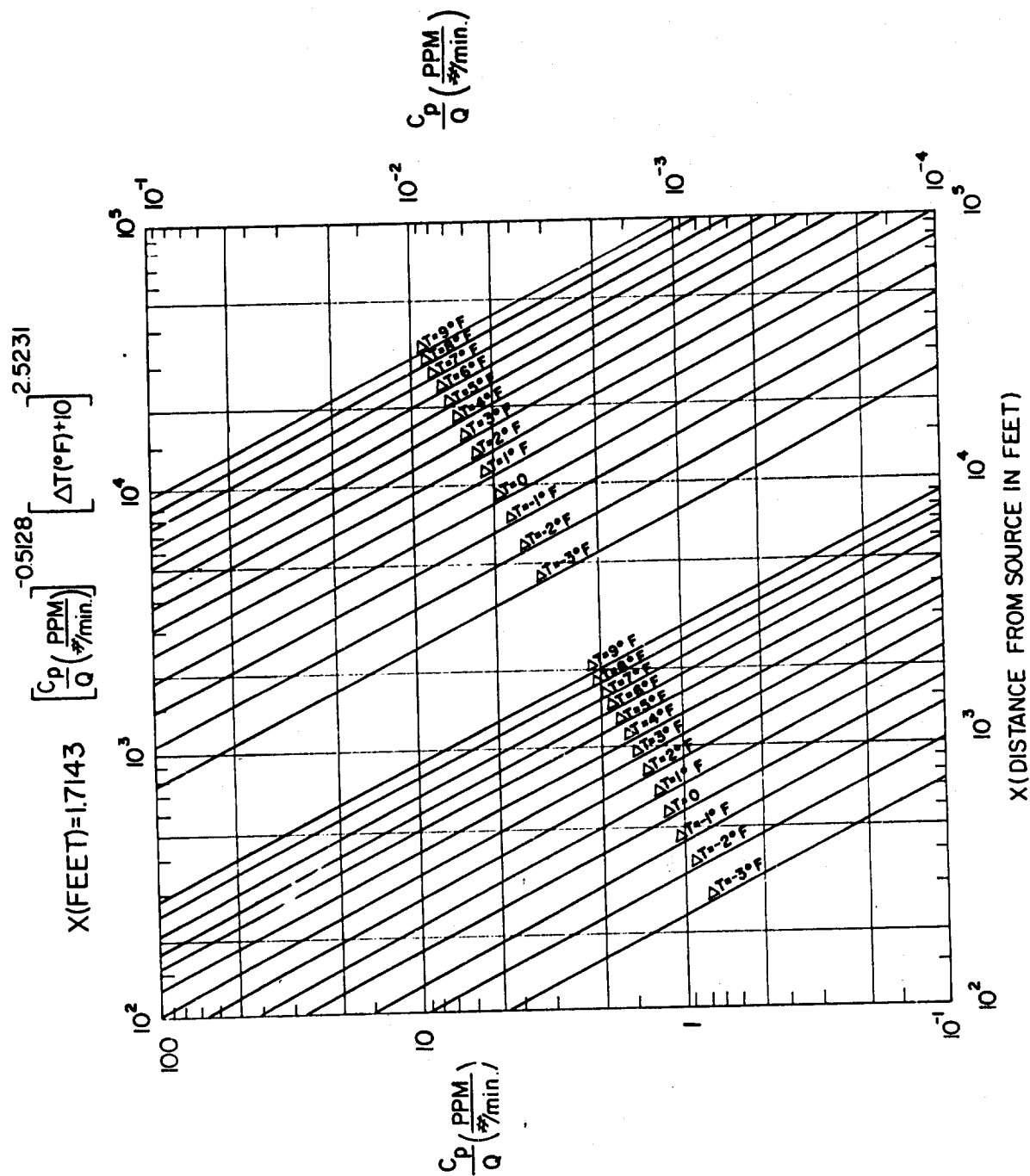


FIGURE 12. DIFFUSION NOMOGRAM FOR NORMAL PROPYL NITRATE ($\text{C}_3\text{H}_7\text{NO}_3$). THRESHOLD VALUE (MAC) IS 25 PPM OR 110 MG/M³.

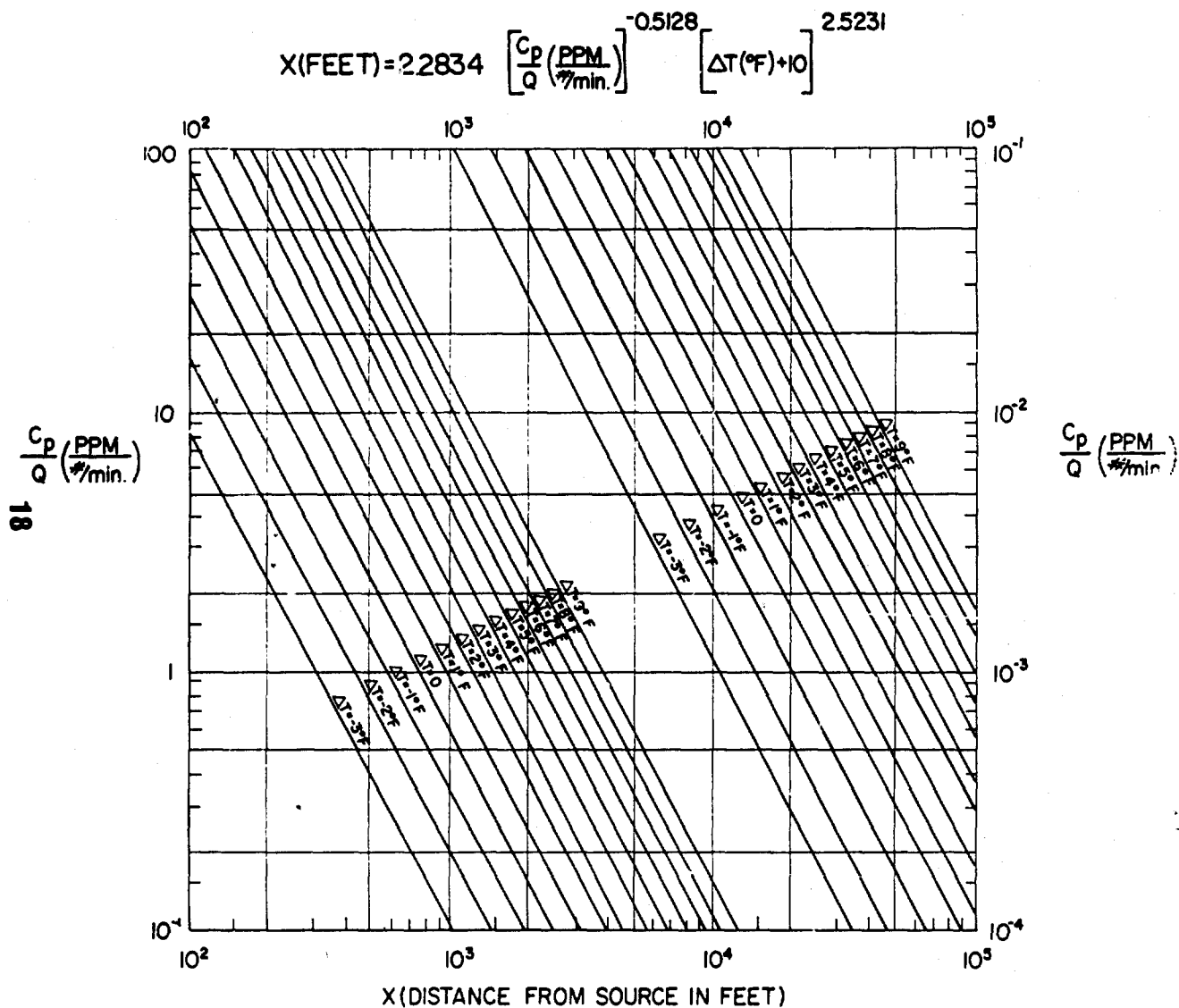


FIGURE 13. DIFFUSION NOMOGRAM FOR UNSYMMETRICAL DIMETHYLHYDRAZINE $[(\text{CH}_3)_2\text{NNH}_2]$. THRESHOLD VALUE (MAC) IS 0.5 PPM OR 1.0 MG/M³.

TABLE 2. DOWNWIND TRAVEL DISTANCE FOR ANILINE AS A FUNCTION OF CP/0 AND DELTA T

CP/0	DELTA T (FEET)												
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0.001	8558	11986	16134	21047	26769	33341	40803	49192	58546	68899	80287	92742	106297
0.002	5997	8400	11307	14751	18761	23367	28596	34476	41032	48288	56269	64498	74498
0.003	4871	6823	9195	11981	15239	18980	23228	28004	33328	39222	45705	52796	60512
0.004	4203	5887	7925	10338	13149	16377	20042	24162	28757	33842	39436	45554	52212
0.005	3744	5251	7068	9220	11727	14606	17875	21550	25647	30183	35172	40628	46566
0.006	3414	4782	6437	8397	10680	13302	16279	19626	23358	27489	32032	37002	42410
0.007	3154	4418	5948	7759	9868	12291	15042	18134	21583	25399	29598	34189	39186
0.008	2946	4126	5554	7245	9215	11477	14046	16934	20154	23718	27639	31926	36593
0.009	2773	3884	5228	6821	8675	10805	13223	15942	18973	22328	26019	30055	34448
0.010	2627	3680	4953	6462	8219	10236	12527	15103	17975	21154	24650	28474	32636
0.020	1841	2579	3471	4529	5760	7174	8780	10585	12598	14825	17276	19956	22873
0.030	1495	2095	2820	3678	4678	5827	7131	8598	10232	12042	14032	16209	18579
0.040	1290	1807	2433	3174	4037	5028	6153	7418	8829	10390	12108	13986	16030
0.050	1151	1612	2170	2831	3600	4484	5488	6616	7874	9267	10798	12474	14297
0.060	1048	1468	1976	2578	3279	4084	4998	6025	7171	8440	9835	11360	13021
0.070	968	1356	1826	2382	3029	3773	4618	5567	6626	7798	9087	10487	12031
0.080	904	1266	1705	2224	2829	3524	4312	5199	6188	7282	8486	9802	11235
0.090	851	1192	1605	2094	2663	3317	4059	4894	5825	6855	7988	9227	10576
0.100	806	1129	1520	1984	2523	3143	3846	4637	5518	6494	7568	8742	10020
0.200	565	791	1065	1390	1768	2202	2695	3250	3867	4551	5304	6127	7022
0.300	459	643	865	1129	1436	1789	2189	2639	3141	3697	4308	4976	5702
0.400	396	555	747	974	1239	1543	1889	2277	2710	3190	3717	4294	4921
0.500	353	495	666	869	1105	1376	1685	2031	2417	2845	3315	3829	4389
0.600	321	450	606	791	1006	1253	1534	1850	2201	2591	3019	3488	3987
0.700	297	416	560	731	930	1158	1417	1709	2034	2394	2790	3222	3696
0.800	277	388	523	683	868	1081	1324	1596	1899	2235	2605	3009	3449
0.900	261	366	492	642	817	1018	1246	1502	1788	2104	2452	2833	3247
1.000	247	346	466	609	774	964	1180	1423	1694	1994	2323	2684	3076
1.200	225	315	425	554	705	878	1075	1296	1543	1816	2116	2444	2801
1.400	208	291	392	512	651	812	993	1198	1425	1678	1955	2258	2588
1.600	194	272	366	478	608	758	928	1118	1331	1567	1826	2109	2417
1.800	183	256	345	450	573	713	873	1053	1252	1475	1719	1985	2275
2.000	173	243	327	426	543	676	827	997	1187	1397	1628	1881	2156
2.200	165	231	311	406	517	644	788	950	1130	1330	1550	1791	2053
2.400	158	221	298	388	494	615	753	908	1081	1272	1483	1713	1963
2.600	151	212	286	373	474	591	723	872	1038	1221	1423	1644	1884
2.800	146	204	275	359	456	569	696	839	999	1176	1370	1583	1814
3.000	141	197	265	346	441	549	672	810	964	1135	1322	1528	1751

TABLE 1. - DOWNWIND TRAVEL DISTANCE FOR CLOUDS OF DIFFERENT HEIGHTS AS A FUNCTION OF CP/W AND DELTA T

DELTA T DEG F (FEET)														
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	
CP/W	8590	12031	16195	21127	26870	33467	40956	49377	58766	69159	80589	93091	106698	
0.001	8590	12031	16195	21127	26870	33467	40956	49377	58766	69159	80589	93091	106698	
0.002	6020	8432	11350	14806	18832	23455	28704	34606	41186	48470	56481	65243	74779	
0.003	4890	6849	9219	12027	15296	19052	23315	28109	33454	39370	45877	52994	60740	
0.004	4219	5909	7955	10377	13198	16438	20117	24253	28865	33970	39585	45725	52409	
0.005	3763	5270	7094	9255	11771	14661	17942	21631	25744	30297	35304	40781	46742	
0.006	3427	4800	6461	8429	10720	13352	16340	19700	23446	27592	32153	37141	42570	
0.007	3166	4435	5970	7788	9905	12337	15098	18203	21664	25495	29709	34318	39334	
0.008	2957	4141	5575	7273	9250	11521	14099	16998	20230	23808	27743	32047	36731	
0.009	2783	3899	5248	6846	8708	10845	13273	16002	19044	22412	26117	30168	34578	
0.010	2637	3694	4972	6486	8250	10275	12574	15160	18043	21233	24743	28581	32759	
0.020	1848	2589	3484	4546	5782	7201	8813	10625	12645	14881	17341	20031	22959	
0.030	1501	2102	2830	3692	4696	5849	7158	8630	10271	12087	14085	16270	18649	
0.040	1295	1814	2442	3186	4052	5047	6176	7446	8862	10429	12153	14039	16091	
0.050	1155	1618	2178	2841	3614	4501	5508	6641	7904	9302	10839	12521	14351	
0.060	1052	1473	1983	2588	3291	4099	5017	6048	7198	8471	9872	11403	13070	
0.070	972	1361	1833	2391	3041	3788	4635	5588	6651	7827	9121	10536	12076	
0.080	907	1271	1711	2233	2840	3537	4328	5219	6211	7309	8517	9839	11277	
0.090	854	1197	1611	2102	2673	3330	4075	4913	5847	6881	8018	9262	10616	
0.100	809	1134	1526	1991	2533	3154	3860	4654	5539	6519	7596	8775	10058	
0.200	567	794	1069	1395	1775	2211	2705	3262	3882	4569	5324	6150	7049	
0.300	460	645	869	1133	1441	1795	2197	2649	3153	3711	4324	4995	5725	
0.400	397	557	749	978	1244	1549	1896	2286	2721	3202	3731	4310	4940	
0.500	354	496	668	872	1109	1382	1691	2039	2426	2856	3328	3844	4406	
0.600	323	452	609	794	1010	1258	1540	1857	2210	2601	3031	3501	4012	
0.700	298	418	562	734	933	1163	1423	1715	2042	2403	2800	3235	3707	
0.800	278	390	525	685	871	1086	1329	1602	1907	2244	2615	3020	3462	
0.900	262	367	494	645	820	1022	1251	1508	1795	2112	2461	2843	3259	
1.000	248	348	468	611	777	968	1185	1429	1700	2001	2332	2694	3088	
1.200	226	317	426	556	708	882	1079	1301	1549	1822	2124	2453	2812	
1.400	209	293	394	514	654	815	997	1202	1431	1684	1962	2267	2598	
1.600	195	273	368	480	611	761	931	1123	1336	1572	1832	2117	2426	
1.800	183	257	346	452	575	716	876	1057	1258	1480	1725	1993	2284	
2.000	174	244	328	428	545	678	830	1001	1192	1402	1634	1888	2164	
2.200	165	232	312	408	519	646	791	953	1135	1335	1556	1798	2061	
2.400	158	222	299	390	496	618	756	912	1085	1277	1488	1719	1971	
2.600	152	213	287	374	476	593	726	875	1041	1226	1428	1650	1891	
2.800	146	205	276	360	458	571	699	842	1003	1180	1375	1589	1821	
3.000	141	198	266	348	442	551	674	813	968	1139	1327	1533	1757	

TABLE 4. DOWNWIND TRAVEL DISTANCE FOR ETHYLENE OXIDE AS A FUNCTION OF CP/O AND DELTA T

CP/O	DELTA T DEG F (FEET)												
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0.001	12565	17599	23689	30903	39304	48953	59909	72226	85960	101161	117881	136168	156071
0.002	8806	12334	16602	21658	27546	34309	41987	50620	60245	70899	82617	95434	109382
0.003	7153	10018	13485	17592	22375	27868	34102	41116	48935	57588	67107	77517	88847
0.004	6172	8644	11636	15179	19306	24045	29426	35477	42222	49689	57902	66885	76660
0.005	5504	7709	10377	13538	17218	21445	26245	31641	37657	44316	51641	59652	68371
0.006	5013	7021	9451	12329	15681	19531	23902	28816	34296	40361	47032	54328	62268
0.007	4632	6487	8733	11392	14489	18046	22085	26626	31689	37293	43457	50198	57535
0.008	4325	6058	8155	10638	13530	16852	20623	24864	29591	34825	40581	46876	53727
0.009	4072	5703	7677	10014	12737	15864	19415	23406	27857	32783	38202	44128	50578
0.010	3857	5403	7273	9488	12067	15030	18393	22175	26392	31059	36193	41807	47918
0.020	2703	3787	5097	6649	8457	10533	12891	15541	18497	21768	25365	29301	33583
0.030	2196	3076	4140	5401	6869	8556	10471	12624	15024	17681	20603	23800	27278
0.040	1894	2654	3572	4660	5927	7382	9034	10892	12963	15256	17777	20535	23537
0.050	1690	2367	3186	4156	5286	6584	8057	9714	11561	13606	15855	18315	20992
0.060	1539	2155	2901	3785	4814	5996	7338	8847	10529	12392	14440	16680	19118
0.070	1422	1992	2661	3497	4448	5540	6780	8175	9729	11450	13342	15412	17665
0.080	1328	1860	2503	3266	4154	5174	6332	7634	9085	10692	12459	14392	16496
0.090	1250	1751	2357	3074	3910	4870	5960	7186	8553	10065	11729	13548	15529
0.100	1184	1659	2233	2913	3705	4614	5647	6808	8103	9536	11112	12836	14712
0.200	830	1162	1565	2041	2596	3234	3958	4771	5679	6683	7788	8996	10311
0.300	674	944	1271	1658	2109	2627	3214	3875	4612	5428	6325	7307	8375
0.400	581	814	1096	1430	1819	2266	2773	3344	3980	4684	5458	6305	7226
0.500	518	726	978	1276	1623	2021	2474	2982	3549	4177	4868	5623	6445
0.600	472	661	890	1162	1478	1841	2253	2716	3232	3804	4433	5121	5869
0.700	436	611	823	1073	1365	1701	2081	2509	2967	3515	4096	4732	5423
0.800	407	571	768	1002	1275	1588	1944	2343	2789	3282	3825	4418	5064
0.900	383	537	723	944	1200	1495	1830	2206	2626	3090	3601	4159	4767
1.000	363	509	685	894	1137	1416	1733	2090	2487	2927	3411	3941	4517
1.200	331	463	624	814	1036	1290	1579	1903	2265	2666	3107	3589	4113
1.400	306	428	576	752	957	1192	1459	1759	2093	2463	2871	3316	3801
1.600	285	400	538	702	893	1113	1362	1642	1955	2300	2681	3096	3549
1.800	269	376	507	661	841	1048	1282	1546	1840	2165	2523	2915	3341
2.000	254	356	480	626	797	993	1215	1465	1743	2052	2391	2762	3165
2.200	242	339	457	596	759	945	1157	1395	1660	1954	2277	2630	3014
2.400	232	325	437	570	726	904	1106	1334	1588	1868	2177	2515	2883
2.600	222	312	420	547	696	867	1062	1280	1524	1793	2090	2414	2767
2.800	214	300	404	527	670	835	1022	1232	1467	1726	2012	2324	2664
3.000	207	289	390	509	647	806	987	1190	1416	1654	1942	2243	2571

TABLE 5. DETERMINED TRAVEL DISTANCE FOR FLUORINE AS A FUNCTION OF CP/D AND DELTA T

CP/D	DELTA T (FEET)												
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0.001	13555	18985	25556	33338	42401	52811	64629	77917	92733	109132	127167	146898	168368
0.002	9500	13306	17911	23365	29717	37012	45295	54608	64992	76485	89127	102953	118001
0.003	7716	10806	14548	18978	24138	30064	36792	44356	52790	62126	72394	83625	95844
0.004	6658	9325	12552	16375	20827	25940	31745	38272	45549	53605	62464	72155	82701
0.005	5938	8317	11195	14604	18575	23135	28313	34134	40624	47803	55710	64353	73758
0.006	5404	7574	10196	13301	16917	21070	25785	31087	36998	43541	50737	58609	67175
0.007	4997	6999	9421	12290	15631	19468	23825	28724	34186	40231	46881	54154	62069
0.008	4666	6535	8797	11476	14596	18180	22248	26823	31923	37569	43778	50570	57961
0.009	4392	6152	8282	10804	13741	17114	20944	25251	30052	35367	41212	47605	54563
0.010	4161	5829	7846	10235	13018	16214	19843	23923	28471	33506	39044	45102	51694
0.020	2916	4085	5499	7173	9124	11363	13907	16766	19954	23483	27364	31609	36229
0.030	2369	3318	4466	5827	7411	9230	11296	13618	16208	19074	22227	25675	29428
0.040	2044	2863	3854	5027	6394	7964	9746	11750	13985	16458	19178	22153	25391
0.050	1823	2553	3437	4484	5703	7103	8692	10480	12472	14678	17106	19758	22646
0.060	1660	2325	3130	4083	5194	6469	7916	9544	11359	13368	15578	17994	20624
0.070	1534	2148	2892	3773	4799	5977	7315	8819	10496	12352	14393	16626	19057
0.080	1432	2006	2701	3523	4481	5581	6831	8235	9801	11534	13441	15526	17795
0.090	1348	1889	2542	3317	4218	5254	6430	7752	9226	10858	12653	14616	16752
0.100	1277	1789	2409	3142	3997	4978	6092	7345	8741	10287	11987	13847	15871
0.200	895	1254	1688	2202	2801	3489	4269	5147	6126	7210	8401	9705	11123
0.300	727	1018	1371	1789	2275	2834	3468	4181	4976	5856	6824	7883	9035
0.400	627	879	1183	1543	1963	2445	2992	3607	4293	5053	5888	6801	7795
0.500	559	784	1055	1376	1751	2180	2668	3217	3829	4506	5251	6066	6953
0.600	509	714	961	1253	1594	1986	2430	2930	3487	4104	4782	5524	6332
0.700	471	659	868	1158	1473	1835	2245	2707	3222	3792	4419	5104	5851
0.800	439	616	829	1081	1375	1713	2097	2528	3009	3541	4126	4767	5463
0.900	414	580	780	1018	1295	1613	1974	2380	2832	3333	3884	4487	5143
1.000	392	549	739	964	1227	1528	1870	2255	2683	3158	3680	4251	4873
1.200	357	500	673	878	1117	1392	1703	2053	2444	2876	3352	3872	4438
1.400	330	462	622	811	1032	1286	1574	1897	2258	2658	3097	3577	4100
1.600	308	431	581	758	964	1201	1469	1772	2109	2482	2892	3341	3829
1.800	290	406	547	713	907	1130	1383	1668	1985	2336	2722	3145	3604
2.000	274	385	518	676	860	1071	1310	1580	1881	2213	2579	2979	3415
2.200	261	366	493	643	819	1020	1248	1505	1791	2108	2456	2837	3252
2.400	250	350	472	615	783	975	1193	1439	1713	2016	2349	2713	3110
2.600	240	336	453	591	751	936	1145	1381	1644	1935	2254	2604	2985
2.800	231	324	436	569	723	901	1103	1330	1582	1862	2170	2507	2874
3.000	223	312	421	549	698	870	1064	1283	1527	1798	2095	2420	2774

TABLE 6. DOWNWIND TRAVEL DISTANCE FOR HYDRAZINE AS A FUNCTION OF ΔT AND ΔL

DELIA T DEG F (FEET)														
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	
CP/10	14792	20718	27887	36379	46269	57628	70525	85026	101193	119088	138771	160299	183728	
0.001	10367	14520	19545	25496	32428	40389	49428	59550	70921	83463	97258	112346	128766	
0.002	8420	11794	15875	20710	26340	32806	40141	48403	57606	67794	78999	91254	104592	
0.003	7265	10176	13698	17864	22727	28306	34641	41764	49705	58495	68163	78737	90246	
0.004	6480	9076	12216	15937	20269	25246	30895	37248	44330	52170	60793	70224	80487	
0.005	5901	8266	11126	14514	18460	22992	28138	33923	40373	47513	55366	63955	73303	
0.006	5453	7637	10280	13411	17057	21245	25990	31345	37305	43902	51158	59094	67731	
0.007	5092	7132	9600	12523	15928	19838	24278	29270	34836	40996	47772	55183	63249	
0.008	4793	6714	9037	11789	14994	18676	22855	27554	32794	38593	44972	51948	59541	
0.009	4541	6361	8562	11169	14206	17693	21653	26105	31069	36563	42606	49216	56410	
0.010	4382	6203	8404	10911	13948	17435	21395	25847	30811	36315	42368	49080	56353	
0.020	3182	4458	6000	7828	9956	12400	15175	18296	21774	25625	29861	34493	39535	
0.030	2585	3621	4874	6358	8087	10072	12326	14861	17686	20814	24255	28017	32112	
0.040	2230	3124	4205	5486	6977	8691	10636	12822	15260	17959	20928	24174	27708	
0.050	1989	2786	3750	4893	6223	7751	9485	11436	13610	16017	18665	21560	24712	
0.060	1811	2537	3416	4456	5667	7059	8639	10415	12395	14588	16999	19636	22506	
0.070	1674	2345	3156	4117	5237	6522	7982	9623	11453	13479	15707	18143	20795	
0.080	1563	2189	2947	3845	4890	6091	7454	8986	10695	12587	14667	16942	19419	
0.090	1471	2061	2774	3619	4603	5734	7017	8460	10068	11849	13807	15949	18281	
0.100	1394	1953	2628	3429	4361	5432	6648	8015	9539	11226	13081	15110	17319	
0.200	977	1368	1842	2403	3056	3807	4659	5617	6685	7867	9168	10590	12138	
0.300	793	1111	1496	1952	2483	3042	3784	4562	5430	6390	7447	8602	9859	
0.400	684	959	1291	1684	2142	2668	3265	3936	4685	5514	6425	7422	8507	
0.500	610	855	1151	1502	1910	2379	2912	3511	4178	4917	5730	6619	7587	
0.600	556	779	1048	1368	1740	2167	2652	3197	3805	4478	5219	6028	6910	
0.700	514	719	969	1264	1607	2002	2450	2954	3516	4138	4822	5570	6384	
0.800	480	672	904	1180	1501	1870	2288	2759	3283	3864	4503	5201	5962	
0.900	451	632	851	1111	1413	1760	2154	2597	3091	3638	4239	4897	5612	
1.000	428	599	807	1052	1339	1667	2041	2460	2928	3446	4016	4639	5317	
1.200	389	546	735	958	1219	1519	1859	2241	2667	3139	3657	4225	4842	
1.400	360	504	679	886	1126	1403	1717	2070	2464	2900	3379	3904	4474	
1.600	336	471	634	827	1052	1310	1604	1933	2301	2708	3156	3645	4178	
1.800	316	443	597	778	990	1233	1510	1820	2166	2549	2971	3432	3933	
2.000	300	420	565	737	938	1168	1430	1724	2052	2415	2814	3251	3726	
2.200	285	400	538	702	893	1113	1362	1642	1954	2300	2680	3096	3549	
2.400	273	382	515	672	854	1064	1302	1570	1869	2200	2563	2961	3394	
2.600	262	367	494	645	820	1021	1250	1507	1794	2111	2460	2842	3257	
2.800	252	353	476	620	789	983	1203	1451	1727	2032	2368	2736	3136	
3.000	243	341	459	599	762	949	1162	1400	1667	1962	2286	2641	3027	

TABLE 7. DOWNWIND TRAVEL DISTANCE FOR HYDROGEN FLUORIDE AS A FUNCTION OF CP/Q AND DELTA T

CP/0	DELTA T DEG F (FEET)													+9
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8		
0.001	18835	26381	35510	46324	58917	73382	89804	108268	128855	151642	176705	204118	233952	263965
0.002	13200	18489	24887	32466	41292	51429	62939	75880	90308	106278	123844	143056	163965	183183
0.003	10722	15018	20215	26371	33540	41774	51123	61634	73354	86226	100594	116199	133183	1514915
0.004	9251	12958	17442	22754	28939	36044	44111	53180	63292	74485	86796	100261	114915	132489
0.005	8251	11557	15556	20293	25810	32147	39341	47430	56448	66431	77411	89420	102489	121341
0.006	7514	10525	14167	18482	23506	29277	35829	43196	51410	60501	70501	81438	93341	105381
0.007	6943	9725	13091	17077	21720	27052	33106	39913	47502	55903	65142	75248	86246	98238
0.008	6484	9081	12224	15947	20282	25261	30915	37271	44358	52203	60831	70268	80538	91658
0.009	6104	8549	11508	15012	19093	23781	29103	35087	41758	49143	57265	66149	75817	86480
0.010	5783	8099	10902	14222	18089	22530	27572	33241	39562	46558	54253	62670	71830	81627
0.020	4053	5676	7641	9968	12678	15790	19324	23297	27727	32630	38023	43922	50342	57342
0.030	3292	4611	6206	8096	10297	12826	15696	18923	22521	26504	30885	35676	40891	46682
0.040	2840	3978	5355	6986	8885	11066	13543	16328	19432	22869	26649	30783	35282	40467
0.050	2533	3548	4776	6230	7924	9870	12079	14562	17331	20396	23767	27454	31467	36458
0.060	2307	3231	4349	5674	7217	8989	11000	13262	15784	18575	21646	25004	28658	32680
0.070	2131	2986	4019	5243	6668	8305	10164	12254	14584	17163	20000	23103	26480	30427
0.080	1990	2788	3753	4896	6227	7756	9491	11443	13619	16027	18676	21574	24727	28278
0.090	1874	2624	3533	4609	5862	7301	8935	10772	12821	15088	17582	20309	23278	26353
0.100	1775	2486	3347	4366	5554	6917	8465	10206	12146	14294	16657	19241	22053	25056
0.200	1244	1742	2346	3060	3892	4848	5932	7152	8513	10018	11674	13485	15456	17554
0.300	1010	1415	1905	2485	3161	3937	4819	5810	6914	8137	9482	10953	12554	14332
0.400	872	1221	1644	2144	2728	3397	4158	5013	5966	7021	8182	9451	10832	12661
0.500	777	1089	1466	1913	2433	3030	3708	4471	5321	6262	7297	8429	9661	10999
0.600	708	992	1335	1742	2215	2759	3377	4072	4846	5703	6645	7676	8799	10000
0.700	654	916	1234	1609	2047	2550	3120	3762	4477	5269	6140	7093	8130	9272
0.800	611	855	1152	1503	1911	2381	2914	3513	4181	4921	5734	6623	7592	8647
0.900	575	805	1084	1415	1799	2241	2743	3307	3936	4632	5398	6235	7147	8147
1.000	545	763	1027	1340	1705	2123	2594	3133	3729	4388	5114	5907	6771	7711
1.200	496	695	936	1221	1553	1934	2367	2853	3396	3997	4657	5380	6166	7066
1.400	458	642	864	1128	1434	1787	2187	2636	3138	3693	4303	4971	5698	6488
1.600	428	600	807	1053	1340	1668	2042	2462	2930	3448	4018	4642	5320	6109
1.800	403	564	760	991	1261	1571	1922	2318	2758	3246	3783	4370	5009	5745
2.000	382	535	720	939	1195	1488	1821	2196	2613	3075	3584	4140	4745	5419
2.200	363	509	685	894	1138	1417	1734	2091	2489	2929	3413	3942	4519	5199
2.400	347	487	656	855	1088	1355	1659	2000	2380	2801	3264	3770	4322	4922
2.600	333	467	629	821	1044	1301	1592	1919	2284	2688	3133	3619	4148	4748
2.800	321	450	606	790	1005	1252	1532	1848	2199	2588	3016	3484	3993	4544
3.000	310	434	585	763	970	1209	1479	1783	2123	2498	2911	3363	3854	4384

TABLE 8. DOWNWIND TRAVEL DISTANCE FOR HYDROGEN PEROXIDE AS A FUNCTION OF CP/Q AND DELTA T

DELTA T DEG F (FEET)														
CP/O	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	
0.001	14348	20096	27051	35288	44882	55900	68410	82476	98158	115517	134609	155491	178218	
0.002	10056	14084	18958	24732	31455	39177	47945	57803	68794	80960	94341	108976	124904	
0.003	8168	11440	15399	20088	25550	31822	38944	46951	55879	65761	76629	88517	101455	
0.004	7047	9871	13287	17335	22045	27457	33602	40511	48214	56741	66119	76376	87539	
0.005	6285	8803	11850	15459	19661	24488	29969	36131	43001	50605	58969	68117	78073	
0.006	5724	8018	10792	14079	17906	22303	27294	32906	39162	46088	53706	62037	71105	
0.007	5289	7408	9972	13009	16545	20607	25219	30404	36186	42585	49624	57322	65700	
0.008	4939	6918	9312	12148	15450	19243	23550	28392	33791	39767	46339	53528	61352	
0.009	4649	6512	8766	11436	14545	18115	22170	26728	31810	37436	43623	50390	57756	
0.010	4405	6170	8305	10834	13780	17163	21004	25322	30137	35467	41329	47740	54718	
0.020	3087	4324	5820	7593	9657	12028	14720	17747	21121	24857	28965	33458	38349	
0.030	2507	3512	4728	6167	7844	9770	11957	14415	17156	20190	23527	27177	31149	
0.040	2163	3030	4079	5321	6768	8430	10317	12438	14803	17421	20300	23449	26877	
0.050	1929	2703	3638	4746	6036	7518	9201	11043	13202	15537	18105	20914	23970	
0.060	1757	2461	3313	4322	5497	6847	8380	10103	12024	14150	16489	19047	21831	
0.070	1624	2274	3061	3994	5080	6327	7743	9335	11110	13075	15236	17599	20171	
0.080	1516	2124	2859	3729	4743	5908	7230	8717	10374	12209	14227	16434	18836	
0.090	1427	1999	2691	3511	4465	5562	6806	8206	9766	11493	13393	15471	17732	
0.100	1352	1894	2550	3326	4230	5269	6448	7774	9253	10889	12689	14657	16800	
0.200	947	1327	1787	2331	2965	3693	4519	5448	6485	7631	8893	10272	11774	
0.300	769	1078	1451	1893	2408	2999	3671	4425	5267	6199	7223	8344	9563	
0.400	664	930	1252	1633	2078	2588	3167	3818	4545	5348	6232	7199	8252	
0.500	592	829	1117	1457	1853	2308	2825	3405	4053	4770	5558	6421	7359	
0.600	539	755	1017	1327	1688	2102	2572	3101	3691	4344	5062	5848	6702	
0.700	498	698	940	1226	1559	1942	2377	2866	3411	4014	4677	5403	6193	
0.800	465	652	877	1145	1456	1814	2220	2676	3185	3748	4368	5045	5783	
0.900	438	613	826	1078	1371	1707	2089	2519	2998	3528	4112	4750	5444	
1.000	415	581	782	1021	1299	1617	1974	2387	2840	3343	3895	4500	5158	
1.200	378	529	713	930	1183	1473	1803	2174	2587	3044	3548	4098	4697	
1.400	349	489	658	859	1093	1361	1666	2008	2390	2813	3278	3787	4340	
1.600	326	457	615	802	1020	1271	1555	1875	2232	2627	3061	3536	4053	
1.800	307	430	579	755	960	1196	1464	1765	2101	2473	2882	3329	3815	
2.000	291	407	548	715	910	1133	1387	1672	1991	2343	2730	3154	3615	
2.200	277	388	522	681	866	1079	1321	1593	1896	2231	2600	3003	3442	
2.400	265	371	499	651	829	1032	1263	1523	1813	2134	2486	2872	3292	
2.600	254	356	479	625	795	991	1212	1462	1740	2048	2386	2757	3159	
2.800	244	343	461	602	766	954	1167	1407	1675	1971	2297	2654	3042	
3.000	236	331	445	581	739	921	1127	1358	1617	1903	2217	2561	2936	

TABLE 9. DOWNWIND TRAVEL DISTANCE FOR MONOMETHYLHYDRAZINE AS A FUNCTION OF CP/Q AND DELTA T

DELTA T DEG F (FEET)														
CP/Q	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	
0.001	12279	17199	23150	30200	38410	47840	58546	70584	84005	98861	115201	133072	152522	
0.002	8606	12053	16225	21166	26920	33529	41032	49469	58875	69287	80738	93264	106895	
0.003	6990	9791	13179	17192	21866	27234	33329	40181	47822	56279	65581	75754	86827	
0.004	6031	8448	11371	14834	18867	23498	28757	34570	41262	48559	56585	65364	74917	
0.005	5379	7534	10141	13230	16827	20958	25648	30921	36801	43309	50467	58296	66816	
0.006	4899	6862	9236	12049	15325	19087	23358	28161	33516	39443	45962	53092	60852	
0.007	4526	6340	8534	11133	14160	17636	21583	26021	30968	36445	42469	49057	56227	
0.008	4227	5920	7969	10396	13223	16469	20154	24298	28919	34033	39658	45810	52506	
0.009	3979	5573	7502	9787	12447	15503	18973	22874	27224	32038	37333	43125	49428	
0.010	3770	5280	7107	9272	11793	14688	17975	21671	25792	30353	35370	40857	46828	
0.020	2642	3700	4981	6498	8265	10294	12598	15188	18076	21273	24789	28634	32819	
0.030	2146	3006	4046	5278	6713	8361	10233	12337	14682	17279	20135	23258	26658	
0.040	1851	2593	3491	4554	5792	7214	8829	10644	12668	14909	17373	20068	23001	
0.050	1651	2313	3113	4062	5166	6434	7874	9493	11299	13297	15494	17898	20514	
0.060	1504	2106	2835	3699	4705	5860	7171	8646	10290	12110	14111	16301	18683	
0.070	1389	1946	2620	3418	4347	5414	6626	7989	9508	11189	13039	15062	17263	
0.080	1297	1817	2446	3192	4059	5056	6188	7460	8879	10444	12176	14065	16120	
0.090	1221	1711	2303	3004	3821	4760	5825	7023	8358	9836	11462	13240	15176	
0.100	1157	1621	2182	2846	3620	4509	5519	6653	7918	9319	10859	12544	14377	
0.200	811	1136	1529	1995	2537	3160	3868	4663	5549	6531	7610	8791	10076	
0.300	658	922	1242	1620	2061	2567	3141	3787	4508	5305	6182	7141	8184	
0.400	568	796	1071	1398	1778	2215	2710	3268	3889	4577	5334	6161	7062	
0.500	507	710	956	1247	1586	1975	2417	2914	3469	4082	4757	5495	6298	
0.600	461	646	870	1135	1444	1799	2201	2654	3159	3718	4332	5004	5736	
0.700	426	597	804	1049	1334	1662	2034	2452	2919	3435	4003	4624	5300	
0.800	398	558	751	980	1246	1552	1899	2290	2726	3208	3738	4318	4949	
0.900	375	525	707	922	1173	1461	1788	2156	2566	3020	3519	4065	4659	
1.000	355	497	670	874	1111	1384	1694	2042	2431	2861	3334	3851	4414	
1.200	323	453	610	796	1012	1261	1543	1860	2214	2605	3036	3507	4020	
1.400	299	418	563	735	935	1165	1425	1719	2046	2407	2805	3241	3714	
1.600	279	391	526	686	873	1088	1331	1605	1910	2248	2620	3026	3468	
1.800	262	368	495	646	822	1024	1253	1511	1798	2116	2466	2849	3265	
2.000	249	348	469	612	779	970	1187	1431	1704	2005	2336	2699	3093	
2.200	237	332	447	583	741	924	1130	1363	1622	1909	2225	2570	2946	
2.400	226	317	427	557	709	883	1081	1303	1551	1826	2128	2458	2817	
2.600	217	304	410	535	681	848	1038	1251	1489	1752	2042	2359	2704	
2.800	209	293	395	515	655	816	999	1204	1433	1687	1966	2271	2603	
3.000	202	283	381	497	632	788	964	1162	1384	1628	1898	2192	2513	

TABLE 10. DOWNWIND TRAVEL DISTANCE FOR NITROGEN TETRAXIDE AS A FUNCTION OF WIND SPEED AND DELTA T

DELTA T DEG F (FEET)														
C/P/O	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	
0.001	12287	17210	23166	30220	38436	47872	58586	70631	84061	98927	115278	133161	152624	
0.002	8611	12062	16236	21180	26938	33551	41060	49502	58914	69333	80792	93326	106966	
0.003	6995	9797	13188	17203	21880	27252	33351	40208	47854	56316	65625	75805	86885	
0.004	6035	8453	11379	14844	18879	23514	28777	34693	41290	48592	56623	65407	74967	
0.005	5383	7539	10148	13239	16838	20972	25665	30942	36825	43338	50501	58335	66861	
0.006	4902	6866	9242	12057	15335	19100	23374	28180	33538	39469	45993	53128	60893	
0.007	4529	6344	8540	11140	14169	17648	21597	25038	30989	36469	42497	49090	56265	
0.008	4230	5924	7975	10403	13231	16480	20168	24315	28938	34056	39684	45841	52541	
0.009	3982	5577	7507	9793	12456	15514	18986	22889	27242	32059	37358	43154	49461	
0.010	3772	5284	7112	9278	11801	14698	17887	21685	25809	30373	35393	40884	46860	
0.020	2644	3703	4984	6502	8270	10301	12606	15195	18088	21287	24805	28653	32841	
0.030	2147	3008	4049	5282	6718	8367	10239	12345	14692	17290	20148	23274	26676	
0.040	1853	2595	3493	4557	5796	7219	8835	10651	12677	14919	17385	20082	23017	
0.050	1652	2314	3115	4064	5169	6439	7880	9500	11306	13306	15505	17910	20528	
0.060	1505	2108	2837	3701	4708	5864	7176	8652	10297	12118	14121	16311	18696	
0.070	1390	1948	2622	3420	4350	5418	6631	7994	9514	11197	13047	15072	17275	
0.080	1298	1819	2448	3194	4062	5059	6192	7465	8884	10456	12184	14074	16131	
0.090	1222	1712	2305	3006	3824	4763	5829	7027	8364	9843	11470	13249	15186	
0.100	1158	1622	2183	2848	3623	4512	5522	6658	7924	9325	10866	12552	14387	
0.200	811	1137	1530	1996	2539	3162	3870	4666	5553	6535	7616	8797	10083	
0.300	654	923	1243	1621	2062	2569	3143	3790	4511	5308	6186	7145	8190	
0.400	568	796	1072	1399	1779	2216	2712	3270	3892	4580	5337	6165	7066	
0.500	507	710	956	1245	1587	1976	2419	2916	3471	4085	4760	5499	6302	
0.600	462	647	871	1136	1445	1800	2203	2656	3161	3720	4335	5008	5740	
0.700	427	598	805	1050	1335	1663	2035	2454	2921	3437	4006	4627	5303	
0.800	398	558	751	980	1247	1553	1901	2292	2727	3210	3740	4321	4952	
0.900	375	525	707	923	1174	1462	1789	2157	2568	3022	3521	4068	4662	
1.000	355	498	670	874	1112	1385	1695	2044	2432	2863	3336	3854	4417	
1.200	323	453	610	796	1013	1261	1544	1861	2215	2607	3038	3510	4023	
1.400	299	419	564	736	936	1165	1426	1720	2047	2409	2807	3243	3717	
1.600	279	391	526	687	874	1084	1332	1606	1911	2249	2621	3028	3471	
1.800	263	368	496	647	822	1024	1254	1512	1799	2118	2468	2851	3267	
2.000	249	349	469	613	779	971	1188	1432	1705	2006	2338	2701	3095	
2.200	237	332	447	583	742	924	1131	1364	1623	1910	2226	2572	2948	
2.400	227	317	427	554	710	884	1082	1304	1552	1827	2129	2460	2819	
2.600	217	305	410	535	681	848	1038	1252	1490	1754	2043	2361	2706	
2.800	209	293	395	515	656	817	1000	1205	1434	1688	1967	2273	2605	
3.000	202	283	381	497	633	788	965	1163	1385	1629	1890	2194	2514	

TABLE 11. DOWNWIND TRAVEL DISTANCE FOR PENTABORANE AS A FUNCTION OF CP/4 AND DELTA T

CP/4	DELTA T DEG F (FEET)																		
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9						
0.001	10447	14632	19696	25693	32678	40701	49810	60051	71469	84108	98009	113214	129761						
0.002	7321	10255	13803	18007	22902	28525	34909	42046	50089	58947	68690	79346	90943						
0.003	5447	8329	11212	14626	18603	23170	28355	34185	40685	47880	55794	64450	73869						
0.004	5131	7187	9674	12620	16051	19992	24466	29496	35105	41313	48141	55609	63737						
0.005	4576	6410	8628	11255	14315	17830	21820	26307	31309	36846	42936	49596	56845						
0.006	4168	5838	7858	10251	13038	16238	19873	23959	28514	33557	39103	45169	51771						
0.007	3851	5394	7260	9472	12047	15004	18362	22137	26347	31006	36131	41736	47836						
0.008	3596	5037	6780	8845	11249	14011	17147	20672	24603	28954	33740	38974	44670						
0.009	3385	4742	6382	8326	10590	13190	16142	19461	23161	27257	31762	36689	42052						
0.010	3207	4492	6047	7888	10033	12496	15293	18437	21943	25823	30091	34760	39840						
0.020	2248	3148	4238	5528	7031	8758	10718	12921	15378	18098	21089	24361	27922						
0.030	1826	2557	3442	4490	5711	7113	8705	10495	12491	14700	17130	19788	22680						
0.040	1575	2206	2970	3874	4928	6138	7511	9056	10778	12684	14780	17073	19569						
0.050	1405	1968	2649	3455	4395	5474	6699	8077	9612	11312	13182	15227	17453						
0.060	1279	1792	2412	3147	4003	4985	6101	7356	8754	10303	12005	13868	15895						
0.070	1162	1656	2229	2908	3698	4606	5637	6796	8089	9519	11093	12814	14687						
0.080	1104	1546	2081	2715	3453	4301	5264	6347	7554	8889	10359	11966	13715						
0.090	1039	1455	1959	2556	3251	4049	4956	5975	7111	8368	9751	11264	12911						
0.100	984	1379	1856	2422	3080	3836	4695	5660	6737	7928	9239	10672	12232						
0.200	690	966	1301	1697	2158	2689	3290	3967	4721	5556	6475	7479	8572						
0.300	560	785	1056	1378	1753	2184	2672	3222	3835	4513	5259	6075	6963						
0.400	483	677	911	1189	1513	1884	2306	2780	3309	3894	4538	5242	6008						
0.500	431	604	813	1061	1349	1680	2056	2479	2951	3473	4047	4675	5358						
0.600	392	550	740	966	1229	1530	1873	2258	2687	3163	3686	4258	4880						
0.700	363	508	684	892	1135	1414	1730	2086	2483	2922	3405	3934	4509						
0.800	339	474	639	833	1060	1320	1616	1948	2319	2729	3180	3673	4210						
0.900	319	447	601	784	998	1243	1521	1834	2183	2569	2994	3458	3964						
1.000	302	423	570	743	945	1178	1441	1738	2068	2434	2836	3276	3755						
1.200	275	385	519	677	861	1072	1312	1582	1883	2217	2583	2984	3420						
1.400	254	356	479	625	795	991	1213	1462	1740	2048	2387	2757	3160						
1.600	237	332	447	584	743	925	1132	1365	1625	1912	2229	2574	2951						
1.800	223	313	421	550	699	871	1066	1285	1530	1800	2098	2423	2778						
2.000	211	296	399	521	662	825	1010	1218	1449	1706	1988	2296	2632						
2.200	201	282	380	496	631	786	962	1160	1380	1624	1893	2186	2506						
2.400	193	270	363	474	603	751	920	1109	1320	1553	1810	2091	2397						
2.600	185	254	349	455	579	721	883	1064	1267	1491	1737	2007	2300						
2.800	178	249	336	438	557	694	850	1025	1219	1435	1672	1932	2214						
3.000	172	241	324	423	538	670	820	989	1177	1385	1614	1865	2137						

TABLE 12. DOWNWIND TRAVEL DISTANCE FOR PERCH-LOVE FLY (MILES)

CP/O	DELTA T DEG F (FEET)												
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0.001	8149	11414	15364	20042	25491	31749	38254	46543	55750	65794	76453	87313	98121
0.002	5711	7599	10767	14046	17865	22251	27231	32830	39072	45982	53582	61844	70441
0.003	4639	6497	8746	11409	14511	18074	22119	26666	31737	37349	43523	50274	57422
0.004	4002	5606	7546	9844	12521	15595	19085	23009	27384	32226	37553	43376	49719
0.005	3570	5000	6730	8780	11167	13908	17021	20521	24423	28742	33492	38644	44363
0.006	3251	4554	6129	7996	10170	12667	15502	18689	22243	26175	30503	35235	40345
0.007	3004	4207	5664	7388	9397	11704	14323	17268	20552	24187	28144	32557	37315
0.008	2805	3929	5289	6899	8775	10929	13375	16125	19192	22586	26319	30402	34845
0.009	2641	3699	4979	6495	8261	10289	12591	15180	18067	21202	24776	28670	32903
0.010	2502	3504	4717	6153	7826	9748	11929	14382	17117	20144	23473	27114	31078
0.020	1753	2456	3306	4312	5485	6831	8360	10079	11996	14117	16451	19003	21781
0.030	1424	1995	2685	3503	4455	5549	6791	8187	9744	11467	13362	15435	17691
0.040	1229	1721	2317	3022	3844	4788	5859	7064	8407	9894	11529	13314	15265
0.050	1096	1535	2066	2695	3428	4270	5226	6300	7498	8824	10283	11878	13614
0.060	998	1398	1882	2455	3122	3889	4759	5738	6829	8037	9365	10818	12399
0.070	922	1291	1739	2268	2885	3593	4397	5302	6310	7426	8653	9995	11456
0.080	861	1206	1623	2118	2694	3355	4106	4951	5892	6934	8080	9334	10698
0.090	810	1135	1528	1994	2536	3159	3866	4660	5547	6528	7607	8787	10071
0.100	768	1075	1448	1889	2402	2992	3662	4415	5255	6184	7207	8325	9541
0.200	538	754	1015	1324	1684	2097	2567	3094	3683	4334	5051	5834	6687
0.300	437	612	824	1075	1367	1703	2085	2513	2991	3520	4102	4739	5431
0.400	377	528	711	928	1180	1470	1799	2169	2581	3037	3540	4089	4686
0.500	336	471	634	827	1052	1311	1604	1934	2302	2709	3157	3647	4180
0.600	306	429	577	753	958	1194	1461	1761	2096	2467	2875	3321	3806
0.700	283	396	533	696	885	1103	1350	1627	1937	2280	2656	3069	3517
0.800	264	370	498	650	827	1030	1260	1520	1809	2129	2481	2865	3284
0.900	248	348	469	612	778	969	1186	1431	1703	2004	2335	2697	3092
1.000	235	330	444	580	737	918	1124	1355	1613	1898	2212	2556	2929
1.200	214	300	404	528	671	836	1024	1234	1469	1729	2015	2327	2668
1.400	198	278	374	488	620	773	946	1140	1357	1597	1862	2150	2465
1.600	185	259	349	455	579	722	883	1065	1267	1492	1738	2004	2302
1.800	174	244	328	429	545	679	831	1002	1193	1404	1636	1890	2167
2.000	165	231	311	406	517	644	788	950	1130	1330	1550	1791	2053
2.200	157	220	296	387	492	613	750	904	1076	1267	1476	1705	1955
2.400	150	210	283	370	470	586	717	855	1029	1212	1412	1631	1869
2.600	144	202	272	355	451	562	688	830	988	1163	1355	1565	1794
2.800	139	194	262	342	435	541	663	799	951	1119	1305	1507	1727
3.000	134	188	253	330	420	523	640	771	918	1081	1259	1455	1667

TABLE 13. DOWNWIND TRAVEL DISTANCE FOR PROPYL NITRATE(NORMAL) AS A FUNCTION OF CP/10 AND DELTA T

CP/10	DELTA T DEG F (FEET)												
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0.001	8043	11266	15164	19782	25160	31237	38350	46236	55027	64758	75462	87168	99909
0.002	5637	7895	10628	13864	17634	21963	26878	32404	38566	45386	52887	61092	70021
0.003	4579	6413	8632	11261	14323	17839	21832	26321	31325	36865	42958	49623	56875
0.004	3951	5533	7448	9717	12358	15392	18837	22710	27029	31809	37066	42816	49074
0.005	3523	4935	6643	8666	11022	13728	16800	20255	24106	28369	33058	38186	43768
0.006	3209	4494	6050	7892	10038	12503	15301	18447	21954	25837	30107	34778	39851
0.007	2965	4153	5590	7292	9275	11552	14138	17045	20286	23873	27819	32134	36831
0.008	2769	3878	5220	6810	8661	10788	13202	15916	18943	22293	25978	30008	34393
0.009	2606	3651	4914	6411	8153	10155	12428	14983	17833	20986	24455	28249	32378
0.010	2469	3459	4656	6073	7725	9621	11774	14195	16895	19882	23169	26763	30675
0.020	1730	2424	3263	4256	5414	6743	8252	9949	11840	13934	16238	18757	21498
0.030	1405	1969	2650	3457	4397	5477	6703	8081	9617	11318	13189	15235	17462
0.040	1213	1699	2287	2983	3794	4726	5783	6972	8298	9766	11380	13145	15067
0.050	1081	1515	2039	2660	3384	4215	5158	6218	7401	8710	10149	11724	13438
0.060	985	1380	1857	2423	3082	3838	4697	5663	6740	7932	9243	10677	12238
0.070	910	1275	1716	2239	2847	3547	4340	5233	6228	7329	8541	9866	11308
0.080	850	1190	1602	2090	2659	3312	4053	4886	5816	6844	7976	9213	10554
0.090	800	1120	1508	1968	2503	3118	3815	4600	5475	6443	7508	8673	9940
0.100	758	1062	1429	1864	2371	2954	3615	4358	5187	6104	7113	8217	9418
0.200	531	744	1001	1306	1662	2070	2533	3054	3635	4278	4985	5758	6600
0.300	431	604	813	1061	1350	1681	2058	2481	2952	3475	4049	4677	5361
0.400	372	521	702	916	1165	1451	1775	2140	2547	2998	3494	4036	4626
0.500	332	465	626	816	1039	1294	1583	1909	2272	2674	3116	3599	4125
0.600	302	423	570	744	946	1178	1442	1738	2069	2435	2838	3278	3757
0.700	279	391	527	687	874	1089	1332	1606	1912	2250	2622	3029	3472
0.800	261	365	492	641	816	1016	1244	1500	1785	2101	2448	2828	3242
0.900	245	344	463	604	768	957	1171	1412	1681	1978	2305	2662	3052
1.000	232	326	438	572	728	907	1109	1338	1592	1874	2184	2522	2891
1.200	212	296	399	521	663	826	1010	1218	1450	1706	1989	2297	2633
1.400	195	274	369	481	612	763	934	1126	1340	1577	1837	2123	2433
1.600	182	256	344	449	572	712	872	1051	1251	1472	1716	1982	2272
1.800	172	241	324	423	538	670	821	984	1178	1386	1615	1866	2134
2.000	163	228	307	401	510	635	777	937	1116	1313	1530	1768	2026
2.200	155	217	292	382	486	605	740	893	1062	1250	1457	1683	1929
2.400	148	208	280	365	464	578	708	854	1016	1196	1394	1610	1845
2.600	142	199	268	350	446	555	679	819	975	1148	1338	1545	1771
2.800	137	192	258	337	429	534	654	789	939	1105	1288	1487	1705
3.000	132	185	249	325	414	516	631	761	906	1066	1243	1436	1658

TABLE 14. DOWNWIND TRAVEL DISTANCE FOR UNSYMMETRICAL DIPHETHYLHYDRAZINE AS A FUNCTION OF CP/O AND DELTA

CP/O	DELTA (FEET)												
	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0.001	10722	15017	20214	26370	33539	41773	51122	61633	73352	86323	100591	116196	133176
0.002	7514	10525	14167	18481	23506	29277	35828	43195	51408	60500	70499	81436	93336
0.003	6103	8549	11507	15012	19093	23780	29102	35086	41757	49142	57264	66147	75815
0.004	5266	7376	9929	12553	16474	20518	25110	30273	36029	42401	49409	57074	65415
0.005	4697	6579	8855	11552	14693	18300	22395	27000	32134	37816	44067	50902	58345
0.006	4277	5991	8065	10521	13381	16666	20396	24590	29265	34441	40133	46354	53135
0.007	3952	5536	7452	9721	12364	15399	18846	22721	27041	31823	37083	42836	49096
0.008	3691	5169	6959	9078	11546	14380	17598	21217	25251	29717	34628	40000	45847
0.009	3474	4866	6551	8546	10869	13537	16567	19973	23771	27975	32599	37656	43160
0.010	3292	4610	6206	8096	10297	12825	15695	18923	22521	26503	30884	35675	40890
0.020	2307	3231	4349	5674	7217	8988	11000	13262	15784	18575	21645	25003	28657
0.030	1874	2624	3533	4609	5862	7301	8935	10772	12820	15088	17581	20309	23277
0.040	1617	2264	3048	3976	5058	6299	7709	9294	11062	13018	15170	17523	20084
0.050	1442	2019	2718	3546	4511	5618	6876	8289	9866	11610	13529	15628	17913
0.060	1313	1839	2476	3230	4108	5117	6262	7549	8985	10574	12322	14233	16314
0.070	1213	1699	2288	2984	3796	4728	5786	6976	8302	9770	11385	13151	15074
0.080	1133	1587	2136	2787	3544	4415	5403	6514	7752	9124	10632	12281	14076
0.090	1066	1494	2011	2623	3337	4156	5086	6132	7298	8569	10008	11561	13251
0.100	1010	1415	1905	2485	3161	3937	4819	5809	6914	8137	9482	10953	12554
0.200	708	992	1335	1742	2215	2759	3377	4071	4846	5703	6645	7676	8798
0.300	575	805	1084	1415	1799	2241	2743	3307	3936	4632	5398	6235	7146
0.400	496	695	936	1221	1552	1934	2367	2853	3396	3997	4657	5380	6166
0.500	442	620	834	1089	1385	1725	2111	2545	3029	3564	4154	4792	5499
0.600	403	564	760	991	1261	1571	1922	2318	2758	3246	3783	4370	5008
0.700	372	521	702	916	1165	1451	1776	2141	2549	2999	3495	4038	4628
0.800	347	487	656	855	1088	1355	1658	2000	2380	2801	3264	3770	4321
0.900	327	458	617	805	1024	1276	1561	1882	2240	2637	3073	3544	4068
1.000	310	434	585	763	970	1209	1479	1783	2123	2498	2911	3363	3854
1.200	282	395	532	695	884	1101	1347	1624	1933	2275	2651	3062	3510
1.400	261	365	492	642	816	1017	1245	1501	1786	2102	2449	2830	3243
1.600	243	341	459	599	762	950	1162	1401	1668	1963	2287	2642	3029
1.800	229	321	432	564	718	894	1094	1319	1570	1848	2153	2487	2851
2.000	217	304	410	534	680	847	1036	1250	1487	1751	2040	2356	2701
2.200	207	290	390	509	647	806	987	1190	1416	1667	1943	2244	2572
2.400	198	277	373	487	619	771	944	1138	1355	1594	1858	2146	2460
2.600	190	266	358	467	594	740	906	1092	1300	1530	1783	2060	2361
2.800	183	256	345	450	572	713	872	1052	1252	1473	1717	1983	2273
3.000	176	247	333	434	552	688	842	1015	1208	1422	1657	1914	2194

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